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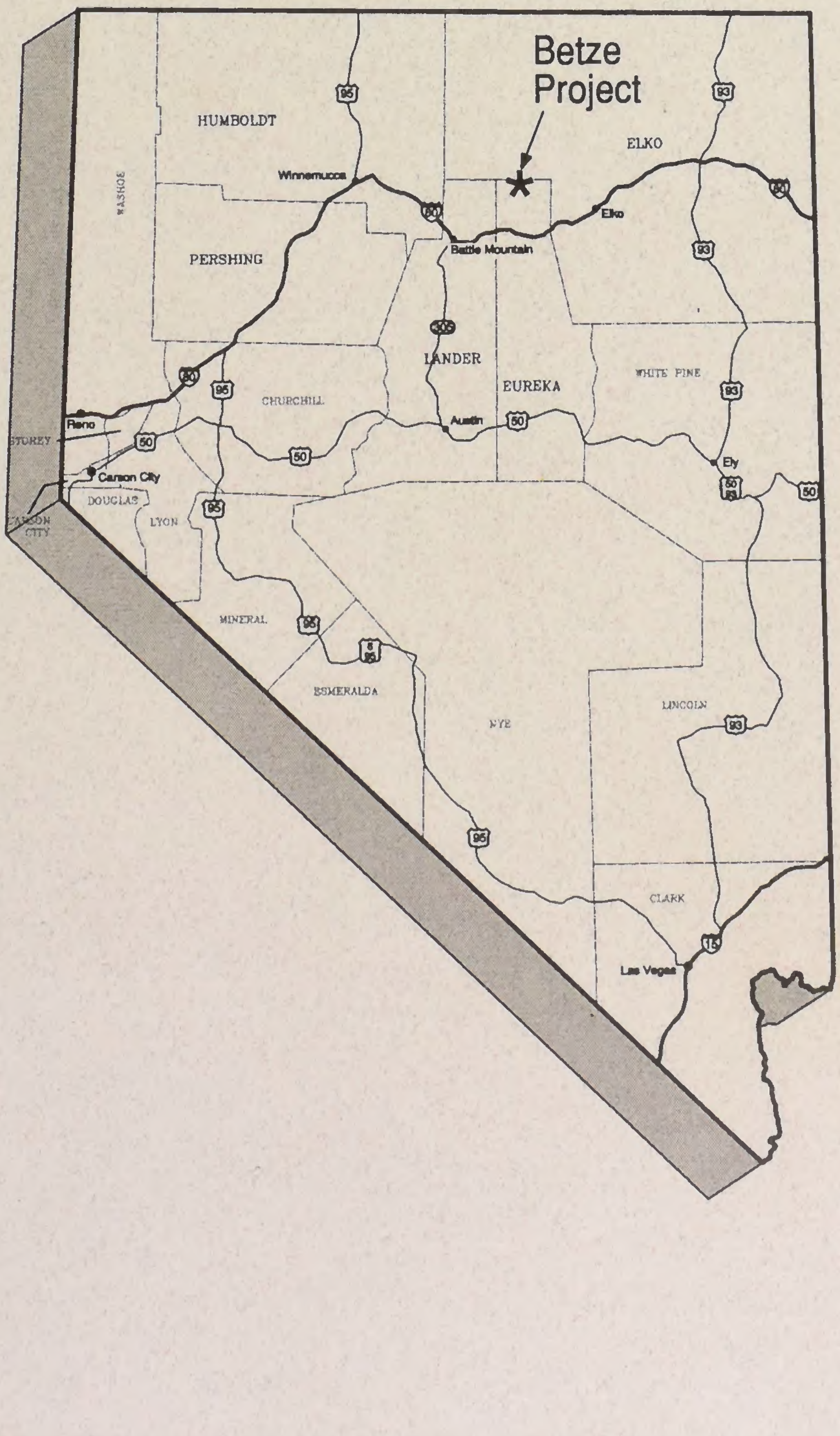
September 2000

# Draft Supplemental Environmental Impact Statement Betze Project

## Barrick Goldstrike Mines Inc.



## *BLM MISSION STATEMENT*

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United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Elko Field Office
3900 East Idaho Street
Elko, Nevada 89801-0611
http://www.nv.blm.gov

In Reply Refer To:
1793.5/3809
N16-88-002P
(NV-013)
August 25, 2000

Dear Reader:

Enclosed for your review and comment is the Draft Supplemental Environmental Impact Statement (DSEIS) for Barrick Goldstrike Inc's Betze-Post Project. The DSEIS serves two purposes: 1) to re-analyze the effect of dewatering for the mine since the dewatering rates and total volume dewatered have been much greater than predicted in the original 1991 EIS for the project and 2) to analyze the impacts of a proposed additional water pipeline which is intended to increase the flexibility of Barrick's water management operations. The Betze-Post project is North America's largest open-pit gold mine, located approximately 25 miles northwest of Carlin, Nevada.

A separate report entitled Cumulative Impact Analysis of Dewatering and Water Management Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project analyzes the cumulative effects of dewatering from the three major dewatering projects on the Carlin Trend. This report is available from the Bureau of Land Management, Elko Field Office, or on the internet at www.nv.blm.gov/elko.

The DSEIS addresses those main issues and concerns which were identified by the BLM or raised during the public scoping period held from August 31, 1994, through February 16, 1998. By analyzing the impacts of Barrick's dewatering operations, the BLM, in conjunction with all interested parties, intends to propose mitigation measures that will address the predicted dewatering impacts which are greater than the predicted impacts from the 1991 EIS. By analyzing the predicted impacts of the proposed water management pipeline, the BLM, in conjunction with interested parties, intends to propose mitigation measures that will address impacts resulting from the pipeline. The proposed pipeline is the only proposed action analyzed in this Supplemental EIS as the water management activities are regulated by the State of Nevada. Thus, the only alternatives analyzed in the DSEIS are to permit construction of the water management pipeline or not to permit construction of the water management pipeline.

Following the 60 day public review and comment period, a Final SEIS will be prepared considering information developed from public comments and concerns. The Final SEIS will include mitigation measures that address both the predicted direct impacts from Barrick dewatering operations and the predicted cumulative impacts from the Barrick dewatering operations and other proposed dewatering operations on the Carlin Trend including the Newmont operations at Gold Quarry and the proposed Leeville underground mine.

Public comments concerning the adequacy and accuracy of this document will be accepted during a

60-day comment period ending November 14, 2000. Comments on the DSEIS must be submitted in writing to: **Bureau of Land Management, Elko Field Office, Attn: Kirk Laird, SEIS Coordinator, 3900 E. Idaho St., Elko, NV 89801.**

Also, a public meeting to accept verbal and/or written comments on the DSEIS is scheduled for **Tuesday, September 26, 2000, at 7:00 P.M.** at the **Elko Field Office, 3900 E. Idaho Street, Elko, Nevada**.

The Final EIS may be in an abbreviated format, therefore, I recommend you retain this draft document for reference purposes. It is also available on the internet at www.nv.blm.gov/elko. Your interest in the management of public lands is appreciated. If you have questions or need further information, please contact Kirk Laird, SEIS coordinator, at (775) 753-0200.

Sincerely,

Helen Hankins

Helen Hankins
Field Manager

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# DRAFT

# SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT
# BARRICK GOLDSTRIKE MINES INC.
# BETZE PROJECT

**LEAD AGENCY:**

U.S. Department of the Interior
Bureau of Land Management
Elko Field Office

**COOPERATING AGENCIES:**

U.S. Fish and Wildlife Service
Nevada Division of Wildlife

**PROJECT LOCATION:**

Elko and Eureka Counties, Nevada

**COMMENTS ON THIS DRAFT (SEIS) SHOULD BE DIRECTED TO:**

Kirk Laird, SEIS Project Manager
Bureau of Land Management
Elko Field Office
3900 E. Idaho St.
Elko, NV 89801
(775) 753-0200

**DATE DRAFT SEIS FILED WITH EPA:** September 15, 2000

**DATE BY WHICH COMMENTS MUST BE POSTMARKED TO THE BLM:** November 14, 2000

## ABSTRACT

Following issuance of the Final Environmental Impact Statement (EIS) and Record of Decision for the Betze Project in 1991, Barrick's implementation of ground water pumping, water management operations, and monitoring provided new information regarding pumping requirements and potential impacts of the operations. In addition, Barrick has built a water treatment plant and a buried pipeline and open conveyance system to discharge up to 70,000 gallons per minute to the Humboldt River under a National Pollutant Discharge Elimination System Permit issued in 1996. Lastly, in 1997 Barrick submitted an application to the Bureau of Land Management to amend an existing right-of-way to allow installation of a second pipeline across public domain. This pipeline would improve the efficiency of Barrick's water distribution system. This Supplemental EIS analyzes the potential impacts of Barrick's existing and future water management operations and of the proposed buried pipeline, which is the Proposed Action.

**Responsible Official for SEIS:** Helen Hankins
**Manager, Elko Field Office**

# SUMMARY

Barrick Goldstrike Mines Inc. (Barrick) owns and operates the Goldstrike property, which is located in Elko and Eureka counties, Nevada, approximately 23 miles northwest of Carlin, Nevada. In 1989, Barrick submitted a Plan of Operations (Plan) to the Bureau of Land Management (BLM) for the Betze Project. As provided by the National Environmental Policy Act of 1969 as amended (NEPA), BLM prepared an environmental impact statement (EIS) with respect to Barrick's proposed Plan. The Final EIS (BLM 1991b) and Record of Decision (ROD) (BLM 1991d) for the Betze Project were issued on June 10, 1991. The Final EIS included a description of the environmental impacts projected to result from ground water pumping to be conducted by Barrick to lower the local ground water elevations below the proposed Betze mining operations.

In 1992, Barrick proposed to develop the Meikle Mine, an underground deposit located approximately 1 mile north of the Betze-Post Pit; the BLM prepared an environmental assessment (EA) for the Meikle Mine in May 1993 (BLM 1993a). The EA analyzed the potential impacts of dewatering this underground operation to the operation's ultimate depth of 3600 feet above mean sea level (amsl). In 1994, the BLM prepared a Biological Assessment (BA) of Barrick's Dewatering Operations (BLM 1994b), including both the Betze-Post Pit and the Meikle Mine. The BA analyzed dewatering to an elevation of 4160 feet amsl. Also in 1994, the U.S. Fish and Wildlife Service (USFWS) prepared a Biological Opinion (BO) (USFWS 1994), which concluded that Barrick's dewatering operations to an elevation of 4160 feet would not likely jeopardize the Lahontan cutthroat trout (LCT). The BLM ultimately approved the Meikle Mine dewatering program to an elevation of 4160 feet in the Finding of No Significant Impact and Decision Record (BLM 1994c).

Barrick has conducted ground water modeling and implemented ground water monitoring programs in association with all of these analyses. The monitoring data collected since 1989 have been used to continually update and refine Barrick's ground water model as the basis for the prediction of the depth and areal extent of the cone of depression associated with mine dewatering and water management activities. The results of the data collection programs and ground water analyses are described in this Supplemental EIS. A description of Barrick's ground water model is included in Appendix D.

## Supplemental EIS

Since the Betze EIS was issued, Barrick's implementation of the ground water pumping and management operations and its monitoring of ground water elevations have provided new information regarding the pumping requirements and potential environmental impacts of Barrick's ground water pumping operations at the Goldstrike Mine, which includes the Betze-Post Pit and the underground Meikle Mine. Also, in July 1996 the Nevada Division of Environmental Protection (NDEP) issued a National Pollutant Discharge Elimination System (NPDES) Permit to Barrick authorizing the discharge of up to 70,000 gallons of water per minute (gpm) to the Humboldt River. Barrick completed construction of a treatment plant and conveyance system in August 1997 and discharged water to the Humboldt River from September 1997 through February 1999. In May 1997 Barrick and Elko Land and Livestock Company (ELLCO) submitted an application to the BLM to amend an existing right-of-way to authorize the installation of an additional buried pipeline across public domain land administered by the BLM as part of the existing water conveyance system. Installation of the additional buried pipeline would enhance the operational flexibility of the water distribution system established in Boulder Valley by Barrick and ELLCO.

The BLM recently prepared a Cumulative Impact Analysis (CIA) report (BLM 2000b) to address potential cumulative dewatering and discharge impacts associated with Barrick's Betze Project and Newmont Gold Company's (Newmont's) proposed South Operations Area Project Amendment and Leeville Project. The results of this analysis are summarized in Chapter 5 of this Supplemental EIS. The CIA may result in the implementation of mitigation measures to address the cumulative impacts of the ground water pumping and water management operations of these three mines. The BLM will identify monitoring programs and mitigation measures in conjunction with the affected parties; monitoring and mitigation measures will be specified in the Final EISs for the three projects.

This Supplemental EIS evaluates the environmental effects of Barrick's ongoing Goldstrike Mine water management operations and of installing a second pipeline across public lands. Installation of the buried pipeline is the Proposed Action addressed in this Supplemental EIS.

# Summary of Impacts

## Continued Mine Dewatering and Discharge to the Humboldt River

### Geology

Two sinkholes have been documented to-date in the area affected by dewatering at the Goldstrike Mine: (1) a sinkhole approximately 3.5 miles northwest of the center of the Betze-Post Pit, and (2) a sinkhole approximately 2.8 miles west of the center of the Betze-Post Pit. In addition, an open fracture was discovered in the bottom of the south-central portion of TS Ranch Reservoir in 1990. This fracture presumably existed prior to reservoir development; however, piping and/or dissolution of the fracture-filling material occurred after the reservoir was used to store water.

Available information on the geology in the region and prediction of ground water drawdown were used to identify areas that potentially could be susceptible to sinkhole development. These areas include the large area underlain by carbonate rock located between the Betze-Post Pit and the Gold Quarry Pit, and the area northwest of the Betze-Post Pit. The development of sinkholes can pose a hazard to livestock, humans, and wildlife. If a sinkhole develops in an area containing buildings, roads, or other structures, damage to these structures may result.

### Water Resources and Geochemistry

#### Impacts from Mine Dewatering and Localized Water Management Activities

As of the end of 1998, over 1,500 feet of drawdown of the water table had occurred in the vicinity of the Goldstrike Mine. The area with at least 10 feet of measured drawdown extends approximately 15 miles northwest-southeast and 5 miles northeast-southwest.

Barrick began delivering water to the TS Ranch Reservoir in May 1990. A large percentage of the water that flowed into the reservoir seeped through a fracture in the floor of the reservoir and flowed into the rhyolite formation. The seepage resulted in mounding (increased ground water elevations) in the rhyolite and alluvial aquifers in upper Boulder Valley. In 1992 and 1993, seepage from the reservoir resulted in three new springs (Sand Dune, Knob, and Green springs) in the northeastern portion of Boulder Valley. Barrick continued to infiltrate water into the fracture until early 1996 when ground water mounding and discharge from the springs in Boulder Valley reached a maximum with the combined flows reaching a peak of approximately 30,000 to 35,000 gpm. At the end of 1998, water levels in the Boulder Valley region had risen approximately 70 feet in the Sheep Creek Range and 50 feet in the alluvium in upper Boulder Valley. From April 1996 through early 1999, water management activities were modified to include discharge to the Humboldt River such that excess mine water no longer seeped through the fracture. As a result, the flows in the springs diminished to approximately 5,000 gpm by the end of 1998; ground water mounding also diminished during this period. Beginning again in 1999 and under Barrick's current water management plans, excess water would be allowed to infiltrate into the rhyolite formation in Boulder Valley through the end of mining. However, ground water levels are carefully monitored to keep spring discharges to a minimum. Under this scenario, the area affected by ground water mounding would persist through the end of mining and would gradually dissipate in the postmining period.

A numerical model was used to estimate the areal extent, magnitude, and timing of drawdown from the Goldstrike Mine through the end of mining and into the postmining period. The extent of the 10-foot drawdown contour would expand after mining ceases and would reach a maximum extent approximately 100 years postmining. At 100 years, the 10-foot drawdown contour is predicted to extend approximately 11 miles northwest, 15 miles southeast, and up to 12 miles southwest from the center of the Betze-Post Pit. The expansion of the area of drawdown would result in part from continual long-term passive inflow of ground water to the pit.

As of the end of 1998, there were 14 identified spring sites located within the existing 10-foot drawdown contour; several of the monitored springs had either dried up or had reduced flow. These springs are located in Boulder Creek, Brush Creek, and upper Rodeo Creek in the vicinity of the Betze-Post Pit. Mine dewatering activities have probably caused at least three of these monitored springs to dry up. It is possible that other springs in these areas, in addition to those currently included in the annual monitoring program, also have been affected by mine dewatering.

There are 67 identified spring sites located within the maximum model-predicted area having at least 10 feet of drawdown. Individual springs and perennial stream reaches are supported by discharge from either the regional ground water aquifer system or from more isolated or perched aquifers residing above the regional ground water system. Only those perennial sources that are hydraulically connected to the regional ground water system could potentially be impacted by mine-induced drawdown. Based on available information, significant impacts to springs and perennial waters located on the eastern slope of the Tuscarora Mountains are generally not anticipated. Impacts are likely at local spring and stream reaches located east of the Betze-Post Pit on the western slope of the Tuscarora Mountains as the magnitude and area of drawdown expands in the future. In this region, springs and perennial streams at higher elevations (generally above 6,000 feet) are less likely to be affected than those at lower elevations. Current drawdown patterns and projected drawdown indicate that the area of drawdown is expanding in a northwest direction toward the upper Antelope Creek and Squaw Creek areas. If drawdown extends to this area in the future, some springs and perennial stream reaches, particularly in upper Antelope Creek (below the confluence with Squaw Creek) and lower Squaw Creek, could be affected.

A potential reduction in the baseflow of perennial springs and streams could affect surface water rights within the drawdown area. There are 19 surface water rights that potentially could be impacted by dewatering-induced drawdown. Of these, seven are used for irrigation, seven for stock watering, three for mining and milling, and two for wildlife. The actual potential for impacts to individual water rights would depend on the site-specific hydrologic conditions that control surface water discharge.

The results of hydrologic modeling indicate that water levels in 64 wells potentially could be lowered by 10 to over 100 feet as a result of Barrick's ground water pumping. Specific impacts to individual wells would depend on the well completion, including pump setting, depth, yield, and premining static and pumping water levels. Lowering the water levels in these water supply wells potentially could reduce yield, and/or increase pumping cost, or if the water level were lowered below the pump setting or below the bottom of the well, the well would become unusable.

No detectable changes in ground water quality have been observed in monitoring wells located in areas of Boulder Valley where water management activities have caused ground water mounding. Based on the monitoring to-date, future infiltration activities in Boulder Valley associated with the mine water management activities are not expected to affect water quality in the alluvial and rhyolite ground water system.

Once dewatering operations cease, a pit lake would begin to develop in the Betze-Post Pit. The pit lake is predicted to attain steady state (or equilibrium) conditions at greater than 200 years after mining. After the pit lake level reaches equilibrium, the numerical ground water model predicts that because of evaporation, a long-term cone of drawdown would persist for the foreseeable future. Based on the hydrologic model, the pit lake is predicted to behave as a long-term hydraulic sink; therefore, outflow from the pit lake to the surrounding ground water system is not expected. In the long term, the pit lake water is predicted to be near neutral pH. The predicted concentrations of total dissolved solids and sulfate and concentrations of antimony are predicted to exceed Nevada drinking water standards. Total dissolved solids and sulfate concentrations would gradually increase over time as a result of evapoconcentration of the lake waters. However, since the pit lake is not expected to discharge to either surface or ground water, the pit lake is not expected to degrade surrounding waters of the state.

### Impacts to the Humboldt River

Discharges to the Humboldt River from the Goldstrike Mine were initiated in September 1997 and continued through February 1999. The maximum recorded discharge rate was approximately 57,000 gpm (127 cubic feet per second) during October and November 1997; much smaller discharges occurred due to irrigation during the growing season of 1998. Discharges to the river varied between approximately 22,000 and 50,000 gpm (50 to 110 cubic feet per second) in late 1998 and early 1999 before ceasing altogether.

During the period of Goldstrike Mine discharges, Humboldt River flows were within the natural range of historic flows and mimicked the high snowmelt-derived flows of the 2 years prior to the mine discharges. Since there is a substantial reduction in river channel flows in the downstream direction, modifications to flow conditions were less at Comus and farther downstream than they were at Battle Mountain. Water levels in the river during the high-flow seasons were not affected, and low-flow levels increased by approximately 1 foot. Changes to channel geometry likely were limited to erosion and sedimentation in the low-flow section of the river; these effects were removed or substantially mitigated by much higher flows in the river during spring runoff. Lateral channel migration is not known to have been directly caused by mine discharges. The reaches immediately upstream and downstream of the Goldstrike Mine outfall have undergone changes in position historically, and natural channel modifications are difficult to separate from potential discharge impacts to-date. If future Goldstrike Mine discharges occur, computer simulations indicate that projected impacts would be similar in their limited extent and magnitude to the impacts to-date. Major changes to water uses or water rights for the Humboldt River have not occurred to-date and are not expected from future Goldstrike Mine discharges, if they occur. Based on projected ground water drawdown at the end of mining and 100 years postmining, baseflow impacts to the Humboldt River directly from Goldstrike Mine dewatering are not anticipated.

It is conceivable that if Barrick discharges to the river in wet years, a very small portion of the annual evaporation from the Humboldt Sink may be accounted for by the discharge contributions. As a result, temporarily greater water depths and extent are possible at the sink; in high water years, this additional water could contribute to spillover into the Carson Sink. Impacts from these conditions would not be expected to be frequent or especially detrimental since they have occurred historically, because there are substantial withdrawals from the river upstream of the sinks.

Barrick's outfall discharges recorded between September 1997 and February 1999 have been within permit limitations. Provided that the mine discharges are in accordance with the permit limitations, impacts to water quality in the river are not anticipated. On an average annual basis, the mine discharge represents a load increase in total dissolved solids, boron, copper, fluoride, and zinc compared with Humboldt River premine conditions. The loads from continued Goldstrike Mine discharge would likely increase total dissolved solids, boron, and fluoride loads in the Humboldt Sink over the mine discharge period; however, the relative magnitudes of these potential increases do not appear to be substantial. Nevertheless, depending on concentrations in the Humboldt Sink, parameter solubilities, and other physical and biological factors, these increased loads to the sink potentially could increase concentrations in the sink wetlands.

### Riparian Vegetation

Mine-induced drawdown from Barrick's dewatering could affect 137 acres of the 662 acres of riparian vegetation located within the 10-foot drawdown area. Of these, approximately 135 acres occur in Boulder and Bell creeks (Rock Creek Watershed), 1 acre occurs in Welches Creek (Rock Creek Watershed), and 1 acre associated with Soap Creek (Maggie Creek Watershed). Approximately 13 acres of wetland vegetation associated with isolated seeps and springs also could be affected. Therefore, a total of approximately 150 acres of riparian/wetland vegetation would potentially be affected by mine-induced drawdown.

Previous Goldstrike Mine discharges to the Humboldt River generally did not affect riparian vegetation since the flows were within the natural range of historic flows; minor fluctuations in the water level during this period likely had minimal effects on the extent of riparian and wetland vegetation along the river. Future discharges, if they occur, may affect riparian and wetland vegetation since channel configuration, depth, and sinuosity may change as a result of the increased water level during low-flow periods.

**Terrestrial Wildlife**

Mine dewatering could reduce the amount and extent of surface water and associated riparian habitats of springs, seeps, and perennial stream reaches within the study area that are used by a variety of terrestrial wildlife species. Potential reduction or loss of available water could affect wildlife resources by: (1) a decrease in available water for consumption; (2) loss of breeding, foraging, and cover habitats; (3) reduction in regional carrying capacity; (4) displacement and loss of animals; (5) decrease in biological diversity; (6) possible genetic isolation; (7) reduction in prey availability; and (8) possible long-term impact to population numbers, depending upon the species and relative habitat quality. Incremental habitat loss could affect big game, upland game birds, waterfowl, shorebirds, raptors, songbirds, nongame mammals, reptiles, and amphibians. Ground water drawdown could affect 150 acres of riparian habitat and wetlands used by terrestrial wildlife species. Available water and associated riparian vegetation would be affected in mule deer summer and transitional ranges, resulting in reduced carrying capacity and displaced animals. Pronghorn summer and transitional ranges also would be affected. In addition, increased leaching of minerals and salts into the soils of Boulder Valley would occur as mine dewatering ceases, modifying the upland vegetation into a more salt-tolerant plant community. Over the long term the pit lake is predicted to have a near neutral pH. However, there is a small potential (5 percent probability) that the lake could be acidic during the early years with the pH gradually increasing over time to near neutral conditions. Long-term exposure to future pit lake water quality is not anticipated to cause acute impacts to wildlife, chronic impacts from reduced pH are unknown.

Discharges to the Humboldt River could result in a short-term increase in available water and support of riparian habitats. The support and development of additional backwater or slough areas would provide nesting, brooding, foraging, and resting habitat. Additional open water may occur in the winter period, which would provide increased foraging opportunities. Potential habitat loss (e.g., nesting or foraging areas) from seasonal flooding along the river during high-flow periods (spring and early summer) would be offset by the creation and enhancement of other wetland areas along the river corridor that currently do not receive sufficient water for optimal wildlife habitat. Increased flows into the Humboldt Sink would improve breeding, foraging, and resting opportunities for resident and migratory wildlife species in the short term.

Potential risks to wildlife from additional mine discharges and possible contaminant loading in the Humboldt Sink would likely be similar to those assessed for premining conditions. However, a number of variables exists that make it difficult to predict future conditions. These variables include the dynamic system of the sink, upstream water demands and fluctuating water levels, bioaccumulation factors of certain constituents of concern (e.g., boron, selenium, mercury), and a number of environmental factors.

**Aquatic Resources**

Goldstrike Mine dewatering could reduce water levels or flows in some springs and perennial reaches within the Boulder Creek and upper Antelope Creek drainages. Drawdown is not expected to affect flows in other streams. The effect of decreased perennial streamflows or water levels on aquatic resources would be a reduction of aquatic habitat that supports native fish species, periphyton, and macroinvertebrate communities. Habitat reductions would likely result in decreased numbers in these communities. If stream segments become dry as a result of reduced flows, aquatic habitat and associated biota would be eliminated. Potential changes in water quality as a result of flow reductions would not likely affect biotic communities, since biota are tolerant of fluctuating temperatures and other parameters.

The effects of flow increases on aquatic communities in the Humboldt River would include both beneficial and adverse impacts. Discharges to the river would result in a beneficial impact of increased habitat for fish, macroinvertebrates, and periphyton. However, the possible reduction of shallow pools and braided channels could adversely affect the development of young fish. Increased flows are not expected to affect fish composition. Fish dispersal patterns are expected to be similar to present conditions. Overall, the effects of increased flows on water quality conditions, such as sediment levels, temperature, and metal concentrations, would be minor.

### Threatened, Endangered, Candidate, and Sensitive Species

Mine dewatering could result in reduction of riparian habitats that may be used by the following terrestrial wildlife species: Preble's shrew, six sensitive bat species, bald eagle, golden eagle, Swainson's hawk, ferruginous hawk, northern goshawk, burrowing owl, sage grouse, white-faced ibis, black tern, and Nevada viceroy. The potential reduction in perennial flows or water levels in springs could reduce the amount of riparian and wetland habitats, which may be used by certain species for cover, foraging, breeding, or other biological requirements. The incremental loss of potential foraging areas would not be considered significant for Federally-listed species (i.e., the bald eagle), based on the incidental use by migrating and wintering eagles of the area potentially affected by the project.

Over the long term the pit lake is predicted to have a near neutral pH. However, there is a small potential (5 percent probability) that the lake could be acidic during the early years with the pH gradually increasing over time to near neutral conditions. Long-term exposure to future pit lake water quality by species, such as the bald eagle or bat species, would not cause acute effects from either increased metals or reduced water pH (5 to 6); potential chronic effects from reduced pH levels are more of an unknown. However, since it is expected that future aquatic communities would likely remain low and would not represent a substantial food source for avian or mammalian wildlife, the incidence of potential foraging in the future pit lake by species of special concern would be expected to be incidental and sporadic.

Discharges to the Humboldt River would result in a short-term increase in available water for many of the special status species identified for the study area. Increased flows in the Humboldt River could improve and enhance the riparian community, which could be used by these species for breeding, foraging, resting, and cover. Increased annual flows may result in a greater amount of open water areas during the winter season, which would increase available foraging areas for wintering bald eagles. The potential impacts to species occurring in the Humboldt Sink area from chemical constituents of concern would be the same as discussed for terrestrial wildlife.

The potential short- and long-term effects to special status species would parallel those discussed for general wildlife resources. Possible effects from increased water discharges to the Humboldt River and Humboldt Sink would be the same as discussed for terrestrial wildlife.

The potential effects of drawdown on aquatic species would be limited to springsnails and the Columbia spotted frog. Water level reductions in springs located in upper Antelope Creek would decrease habitat for springsnails. Drawdown would not affect one known spring inhabited by springsnails in upper Willow Creek. In addition, flow reductions in perennial reaches in upper Antelope Creek also may affect potential habitat for the spotted frog. Population numbers may decrease if a large portion of habitat is removed. Drawdown from the Goldstrike Mine is not predicted to affect flows in the Maggie Creek and Rock Creek subbasins, which support existing populations of the Lahontan cutthroat trout and potential habitat and existing populations of the California floater.

### Grazing Management

Impacts that may occur as a result of ground water drawdown from Barrick's water management operations include reduced flow or complete cessation of flow in springs and other water sources. The long-term loss of water sources would result in the reduction or loss of permitted active grazing use within an allotment if alternative water sources are not present within the vicinity of the affected water sources or if lost water sources are not mitigated. The reduced flow or change in a water source from perennial to intermittent would result in a reduction in season of use, which also would affect permitted active grazing use. Drawdown impacts could be localized to water sources within one or several pastures within an allotment. The loss of the majority or all of the water sources within these pastures would likely affect livestock distribution, forage utilization, and grazing management operations.

Some of the water sources (i.e., water-related range improvements and natural perennial water sources) in the Twenty-five and T Lazy S allotments potentially could be affected by Goldstrike Mine drawdown. In the Twenty-five allotment, approximately 30 percent of the natural perennial water sources within the Boulder Creek pasture could potentially be affected by Goldstrike Mine ground water drawdown. Approximately 25 percent of the water related range improvements and approximately 10 percent of the natural perennial water sources in the T Lazy S allotment could be affected by Goldstrike Mine drawdown. The potential long-term loss of these water sources may result in the long-term loss of permitted active grazing use or reduced forage utilization.

During the period of mine dewatering discharge, slightly increased water levels within the Humboldt River floodplain would likely increase the areal extent of herbaceous wetlands immediately adjacent to the river channel. Forage production and the carrying capacity of these narrow areas also would likely increase temporarily. Discharge waters reaching the Humboldt and Carson sinks would not affect grazing management since livestock grazing is not allowed within these areas.

### Socioeconomics

Barrick's mine dewatering and water management operations have provided water for approximately 8,000 additional acres of irrigated hay fields with resulting hay production. In the unlikely event that Barrick were to discharge mine dewatering water to the Humboldt River, there could be a minor increase in available irrigation water associated with additional storage in Rye Patch Reservoir. Mine-induced ground water drawdown from Barrick's dewatering could result in some reduction in water availability for cattle grazing and a slight reduction in hunting and fishing opportunities associated with a reduction in surface water resources.

## Proposed Action (Buried Pipeline)

### Air Quality

Surface disturbance and the operation of heavy machinery would generate fugitive dust during construction; however, this activity would have minimal impacts on local air quality because of the small disturbance area and 2-week time frame for construction.

### Topography and Soils

Local topography would not be affected by installation of the pipeline since the right-of-way would be graded, restored to natural contours, and reclaimed. Based on the entire 200-foot construction right-of-way width being disturbed (which is wider than actually anticipated), a maximum of l8 acres of soils could be temporarily disturbed.

### Water Resources

No impacts to water resources would result from constructing of the pipeline, since natural topography and drainage features would be restored following construction.

### Vegetation, Including Threatened, Endangered, Candidate, or Sensitive Species

A maximum of 18 acres of the big sagebrush/grassland vegetation type could be removed by construction of the proposed pipeline; realistically, less disturbance would occur. The disturbed area would be reclaimed promptly using an approved seed mixture. Herbaceous species (grasses, forbs) would re-establish rapidly, while shrub species (big sagebrush) would re-establish within 5 to 10 years. There is a potential for continued invasive non-native weed establishment along the pipeline right-of-way due to the existence of cheat grass and halogeton on the vicinity (i.e., a seed source).

No impacts to threatened, endangered, candidate, or sensitive plant species would result from implementing the Proposed Action.

### Wildlife, Including Threatened, Endangered, Candidate, or Sensitive Species

Impacts to area wildlife would be limited to a short-term, incremental reduction in habitat and an increase in disturbance from pipeline construction. Potential disturbance factors would include increased noise and human presence during the 2-week construction and subsequent reclamation periods. If these activities were to occur during important seasonal periods (e.g., spring or fall migration), animals would avoid the pipeline right-of-way until initial reclamation has been completed. The impacts to mule deer and pronghorn could be potential displacement, possibly increasing energy requirements during high stress periods (e.g., severe storm events).

If construction occurred during the breeding season (March through August), it is assumed that the annual breeding potential for these displaced species would be lost for that year, but individuals would likely return following construction and successful reclamation. The anticipated displacement of individuals, interference with breeding activities, and possible mortality of the less mobile species would not be expected to result in population-level effects.

Potential direct impacts to special status species from pipeline construction would be limited to the Preble's shrew and burrowing owl. Equipment access and pipeline trenching activities may crush individuals, if either species were to occur within the areas proposed for disturbance. The probability that the shrew occurs in this area would be low; however, the burrowing owl has been documented nesting in the project vicinity. Loss of eggs, young, or incubating adult owls could occur if construction were to occur during the breeding season.

The incremental reduction in the native sagebrush/grassland community from pipeline construction would result in a short-term loss of potentially suitable foraging habitat for the Preble's shrew, long-legged myotis, fringed myotis, Townsend's big-eared bat (both subspecies), bald eagle, golden eagle, Swainson's hawk, ferruginous hawk, burrowing owl, and sage grouse. Upon successful right-of-way reclamation, the foraging opportunities along this pipeline alignment would be expected to approach pre-construction levels.

### Grazing Management

The loss of forage within the area of temporary disturbance would be minimal relative to the total area available for livestock grazing.

### Access and Land Use

The proposed pipeline project would increase the quantity of water that can be delivered for irrigation by approximately 8,000 gpm during peak irrigation periods. There would be no effects to access. The in-place abandonment of the pipeline would result in potential future land use conflicts.

### Cultural Resources

No sites identified within the proposed pipeline project area were determined to be significant or eligible for inclusion on the National Register of Historic Places.

### Visual Resources

The rangeland that would be crossed by the right-of-way would visually accommodate the pipeline project because reclamation would restore the original landform, and revegetation would approximate original colors and textures. The project would be compatible with the BLM's Visual Resource Management Class IV designation.

## No Action

The No Action Alternative would eliminate potential impacts of the Proposed Action on all resources.

## Impact Summary Table

Table S-1 summarizes the impacts and the monitoring and mitigation measures associated with the dewatering and water management operations of the:

- Betze Project, as analyzed in the Betze Project Final EIS (1991b) and the associated Record of Decision (BLM 1991d).

- Meikle Mine Development EA (BLM 1993a) and the associated Finding of No Significant Impact and Decision Record (BLM 1994c), and the Biological Assessment of Barrick's Dewatering Operations (BLM 1994b).

- Goldstrike Mine, including possible discharge to the Humboldt River, as analyzed in this Supplemental EIS.

Table S-2 summarizes the impacts and monitoring and mitigation measures associated with the Proposed Action analyzed in this Supplemental EIS, i.e., the buried pipeline.

All of the monitoring and mitigation measures identified in Tables S-1 and S-2 are measures recommended by the BLM for the Draft Supplemental EIS. The BLM will re-evaluate these measures for the Betze Project Final Supplemental EIS and the Record of Decision.

The impacts identified in the Supplemental EIS are independent of the impacts identified in the original Betze Project EIS; however, the impact analysis in this Supplemental EIS reflects the monitoring programs and mitigation commitments specified in the Betze Project ROD (BLM 1991d). Additional monitoring and mitigation measures for this Supplemental EIS are associated mainly with the dewatering and water management activities. Where applicable, these additional monitoring and mitigation measures tier from relevant monitoring/mitigation identified in the Betze Project ROD.

## Agency Preferred Alternative

In accordance with the National Environmental Policy Act, federal agencies are required by the Council on Environmental Quality (40 Code of Federal Regulations 1502.14[e]) to identify their preferred alternative for a project in the Draft EIS, if a preference has been identified. As discussed in Chapter 1, the Proposed Action for this Supplemental EIS, i.e., the action upon which the BLM will make a decision, is the installation of the buried water pipeline. The BLM has identified the Proposed Action as the agency preferred alternative. The BLM is reviewing monitoring and mitigation measures identified during the analysis of the Proposed Action and Barrick's continuing dewatering and water management operations; the BLM will identify required monitoring and mitigation measures in the Record of Decision for this Supplemental EIS.

## Table S-1

## Summary of Dewatering and Water Management Impacts and Monitoring/Mitigation

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| Impacts | Monitoring/Mitigation | Impacts | Monitoring/Mitigation | Impacts | Monitoring/ Mitigation |
| GEOLOGY | | | | | |
| • No anticipated impact. | • None | • No anticipated impact. | • None | • Two sinkholes have formed in response to mine dewatering; areas underlain by carbonate rock located northwest and southeast of the Betze-Post Pit could be susceptible to future sinkhole development. | • Monitoring and reporting of any suspected subsidence features to BLM.<br>• Develop and implement site-specific remedial measures as approved by the BLM. |
| *WATER RESOURCES AND GEOCHEMISTRY* | | | | | |
| Dewatering and Drawdown | | | | | |
| • Dewatering expected to continue through 2000; target elevation 4,160 feet, with rates up to 29,300 gpm. | • NA | • Decision authorized continuation of dewatering through 2001; dewatering to the target elevation authorized by the Betze EIS. | • Significant modifications of the Plan of Operations for the Meikle Project affecting federal lands must be reviewed and approved by the BLM prior to implementation. | • Dewatering expected to continue until 2010; target elevation 3,576 feet, with rates up to 69,000 gpm. | • NA |
| • Drawdown: Area projected to experience ≥10 feet of drawdown would extend up to 6 miles from pit at end of mining (year 2000), and continue to expand (up to 10 miles from the pit) up to year 2030 and then start to contract. | • Monitoring ground water levels and water quality, and flow and water quality at surface water stations on a monthly basis; monitoring plan reviewed annually by the BLM to determine necessary changes.<br>• Barrick would continue monitoring for a period extending up to 30 years after completion of mining. Monitoring after this period would be funded by a Long-Term Monitoring Fund. | • Area projected to experience >10 feet of drawdown would expand up to 17 miles approximately 30 years after mining (see Figure D-11) followed by recovery to within 45 feet approximately 100 years postmining. | • Expand monitoring network (surface and ground water) between the mine and any LCT habitat, in consultation with BLM and the Nevada State Engineer.<br>• BLM may require additional monitoring as necessary to monitor impacts to LCT or other sensitive resources.[1]<br>• Submittal of all monitoring reports to BLM, quarterly.<br>• Barrick to install and operate reinjection wells, if necessary, to prevent adverse impacts to LCT waters.[1]<br>• If no reasonable or prudent alternatives exist to mitigate impacts to endangered or threatened species, BLM may direct Barrick to cease mining.[1] | • Drawdown: Area projected to experience ≥10 feet of drawdown would extend up to 12 miles from pit at end of mining (year 2010), and continue to expand (up to 15 miles from pit) until 100 years postmining and then start to contract. | • The ground water monitoring system has been expanded since the Betze EIS. The monitoring plan would continue to be reviewed annually by the BLM and revised as necessary.<br>• BLM would review existing funds for adequacy and adjust, if appropriate. |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| Impacts | Monitoring/Mitigation | Impacts | Monitoring/Mitigation | Impacts | Monitoring/ Mitigation |
| *Seeps, Springs, and Perennial Streams* | | | | | |
| • Seeps and Springs: 10-foot drawdown contour projected to encompass 57 springs by end of mining (2000), and 111 seeps and springs by 2030; most of these were expected to show reduced flow or dry up (if hydraulically connected to the regional system). | • Monitoring of stream segments, seeps, and springs (annually), and some stream sites (monthly) and providing results to the BLM.<br>• Establishment of Wetland Mitigation Fund ($660,000) available to the BLM for the protection and or enhancement of riparian and wetlands to mitigate drawdown impacts. | • Seeps and springs could be impacted from drawdown (number not estimated). | • None | • Seeps and Springs: At the end of 1998, several spring and seep sites showed reduced flow or dried up. The projected 10-foot drawdown contour is predicted to encompass 70 spring sites; 44 of these are located in areas where surface waters could be impacted, 26 are located in areas where impacts are less likely. | • Flow and water quality are monitored monthly at stream stations and annually in representative spring sites, and the results are provided to the BLM. This monitoring program would be reviewed at least annually and revised, as necessary, in conjunction with the BLM. Spring monitoring would continue through the end of mining and for up to 30 years postmining. |
| • Streams: The lower perennial reaches of Brush, Bell, and Boulder creeks were expected to have reduced flows. | • Provide funds for the acquisition and maintenance of alternative water sources (e.g., guzzlers, cisterns, purchase of water rights, etc.) (maximum of $50,000). | • Additional impacts to perennial flows from drawdown not identified. | • None | • Streams: Similar to the original EIS, except that drawdown could reduce flows in Antelope Creek and tributaries . | • If surface water monitoring of streams and representative spring sites indicates a reduction of flow potentially resulting from mine-induced drawdown, additional resource inventories would be performed to identify the areal extent and magnitude of impacts to flow in seeps, springs, or perennial stream reaches.<br>• The BLM would evaluate the available information to determine if mitigation is required.<br>• If mitigation is required, a detailed site-specific mitigation plan would be prepared to repair or replace the impacted perennial water resources. Mitigation would depend on the actual impacts, site-specific conditions, and the feasibility of implementation and could include a variety of measures:<br>1. Augmenting or replacing flows by drilling well(s) and pumping or piping water from other nearby sources to restore the average historic baseflow at the perennial water resource (seep, spring, or stream). Any replacement water source used to augment or replace flows would meet the water quality criteria applicable for the historic beneficial use (such as aquatic life, irrigation, or livestock watering). |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| **Impacts** | **Monitoring/Mitigation** | **Impacts** | **Monitoring/Mitigation** | **Impacts** | **Monitoring/ Mitigation** |
| | | | | | 2. On-site or off-site improvements including fencing to limit grazing, installation of guzzlers, or other measures to enhance water yield.<br>• Any approved site-specific mitigation plan would be implemented followed by monitoring and reporting to verify success of the implemented measures. If initial mitigation were unsuccessful, the Authorizing Officer may implement additional site-specific mitigation measures.<br>• Barrick would be responsible for funding all monitoring, resource inventories, mitigation plan development, and implementation of mitigation measures required by the BLM or other state or federal agencies. |
| *Water Rights* | | | | | |
| • Reduction in ground water levels in ground water supply wells during dewatering and recovery. | • If monitoring demonstrates impairment of water rights, the Authorizing Officer may, in consultation with the Nevada State Engineer, require Barrick to provide alternative water sources or assistance to mitigate or eliminate such impacts. | • Impacts to water rights associated with drawdown not identified. | • None | • Additional water rights (surface and ground water) could be affected by mine-induced drawdown. | • Barrick would continue to monitor surface and ground water to determine the extent of drawdown as required by the State Engineer. Adverse impacts to water rights (surface water or ground water) would be mitigated as required by the Nevada Division of Water Resources. |
| *Ground Water Mounding* | | | | | |
| • Mounding would occur in Boulder Valley due to irrigation infiltration. | • None | • Mounding predicted by modeling; impacts associated with ground water mounding not identified. | • None. | • Ground water mounding from infiltration of excess mine dewatering water has been more extensive than originally estimated; mounding reached a maximum in 1996 and is predicted to gradually subside in the future. | • None |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| **Impacts** | **Monitoring/Mitigation** | **Impacts** | **Monitoring/Mitigation** | **Impacts** | **Monitoring/ Mitigation** |
| *Pit Lake* | | | | | |
| • Lake predicted to have neutral pH; potential for elevated arsenic levels. | • Quarterly monitoring of pit water quality for arsenic and other identified constituents of concern until at least 2030,and thereafter if necessary; monitoring activities after 2030 would be funded by the Long-Term Monitoring Fund.<br>• Funding of research of issues related to postmining pit water quality at $50,000 per year for 10 years. | • No additional evaluation. | • None | • Updated predictions indicate lake is likely to have near-neutral pH with antimony concentrations ranging from 0.04-0.06 mg/L; TDS and sulfate are predicted to gradually increase over time. Slight possibility lake may be acidic in early (up to 26) years with associated elevated metals concentrations.<br>• Pit lake predicted to act as a long-term hydraulic sink; outflow to ground water is not expected. Arsenic concentrations predicted to be at or below detection limits. | • None |
| *Humboldt River Flow* | | | | | |
| • No anticipated impacts. | • Barrick is providing $1,000,000 for USGS Humboldt River study. | • No anticipated impact; direct discharge not proposed. | • None | • Excess mine dewatering water was discharged to the Humboldt River from September 1997 through February 1999 at rates ranging from 22,000 to 50,000 gpm. Flows measured in the river were within historic ranges during the discharge period.<br>• Barrick's current plans indicate that future discharges are unlikely; however, Barrick is permitted to discharge in the future up to 70,000 gpm. | • None<br>• Monitoring of the river channel in the vicinity of the discharge outfall, prior to, during, and after the discharge period.<br>• If impacts are identified, Barrick would be responsible for mitigating these impacts with approval from applicable Federal and state agencies. |
| *Humboldt River Water Quality* | | | | | |
| • No anticipated impact. | • None | • No anticipated impact; direct discharge not proposed. | • None | • Discharges were within permit limitations; discharges would likely result in a relatively small incremental increase in TDS, arsenic, boron, and fluoride loads in the Humboldt Sink. | • None |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| Impacts | Monitoring/Mitigation | Impacts | Monitoring/Mitigation | Impacts | Monitoring/ Mitigation |
| VEGETATION (INCLUDING RIPARIAN) | | | | | |
| • Dewatering activities could potentially affect up to 330 acres of riparian vegetation. | • Provide funds for protection and enhancement of riparian and wetland vegetation (maximum contribution of $660,000). | • No dewatering impacts identified. | • None | • Ground water drawdown could affect 136 acres of riparian vegetation in the Boulder Creek drainage and 1 acre in the Maggie Creek drainage. In addition, ground water could affect 13 acres of wetland vegetation associated with isolated seeps and springs. | • Improvement of habitat conditions in the Squaw Valley allotment (also being considered for cumulative effects mitigation). |
| | • Provide funds for post-dewatering revegetation of riparian and wetlands with seedings of container plants (maximum of $40,000). | | | • Approximately 13 acres of wetlands associated with 44 seeps and springs could be affected by flow reductions. | • If seeps and springs were impacted by drawdown, surface water monitoring and mitigation identified in Water Resources and Geochemistry would be applied. |
| • Dewatering discharges could increase the amount of riparian vegetation in the irrigation area and an unnamed drainage. | • Monitor riparian and wetlands until at least 2030.<br>• Provide funds for the acquisition and maintenance of alternative water sources (e.g., guzzlers, cisterns, purchase of water rights, etc.) (maximum of $50,000). | | | • Increased discharge to Humboldt River could result in additional support of riparian vegetation and short-term expansion of riparian community. | • None |
| TERRESTRIAL WILDLIFE | | | | | |
| *Dewatering and Drawdown* | | | | | |
| | | | | • Minor restrictions to small animal movement from water conveyance canal. | • None |
| • Dewatering could result in reduction or loss of available surface water for wildlife use in an estimated 111 seeps and springs by 2030. | • Monitor springs, seeps, riparian areas, and wetlands until at least 2030 (up to $250,000). | • Continued availability of water at the TS Ranch Reservoir for wildlife use. | • None | • Approximately 44 springs, and associated wildlife habitat, are located in areas where surface waters could be affected in the long term. | • None |
| • Dewatering could result in reduction in available water in the lower perennial reaches of Brush, Bell, and Boulder creeks. | • Variety of monitoring points along perennial drainages. | | | • Potential long-term impacts to perennial stream reaches and associated wildlife would be similar to the Betze FEIS; however drawdown could reduce flows in Antelope Creek and its tributaries. | • Monitoring and mitigation of perennial streams, riparian habitat, and wetlands as described under Water Resources and Geochemistry and Vegetation. |
| • Dewatering activities could potentially affect up to 330 acres of riparian habitat. | • Fund protection and enhancement of riparian and wetlands areas (maximum contributed $660,000). | | | • Ground water drawdown could potentially affect 136 acres of riparian habitat in the Boulder Creek drainage and 1 acre in the Maggie Creek drainage. | • Barrick would coordinate with the BLM to implement specific land use changes of the Squaw Valley Allotment, which would provide off-site habitat enhancement for terrestrial wildlife species, including improvements in riparian areas (also being considered for cumulative effects mitigation). |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| Impacts | Monitoring/Mitigation | Impacts | Monitoring/Mitigation | Impacts | Monitoring/ Mitigation |
| • Overall impacts to terrestrial wildlife resources from ground water drawdown activities could include the overall long-term reduction in available surface water; riparian and mesic vegetation; wetland areas; possible loss or reduction in cover, breeding sites, and foraging areas; animal displacement and incremental habitat fragmentation; and possible reduction in the associated habitat carrying capacity of affected areas. | • Fund post-dewatering revegetation of riparian and wetlands with seedlings or container plants (maximum of $40,000).<br>• Fund the acquisition and maintenance of alternative water sources (guzzlers, cisterns, etc.) (up to $50,000). May include (but not be limited to) purchase of water rights at off-site locations or acquisition of wildlife easements to water sources.<br>• Long-term Monitoring and Mitigation Fund of $1,000,000 for review, monitoring, and mitigation of effects not specifically identified in EIS and not covered by reclamation plan. | | | • Ground water drawdown could affect 13 acres of wetland habitat and wildlife associated with perennial reaches and 44 seeps and springs.<br>• Reduction in mesic areas.<br>• Possible decreased riparian plant vigor or loss of vegetative cover.<br>• Possible reduction or loss of cover, breeding sites, and foraging areas.<br>• Possible increases in surface water temperature.<br>• Reduced carrying capacity in habitats affected by loss of available water or riparian vegetation.<br>• Possible reduction in certain animal populations that depend on affected springs, wetlands, or stream reaches. | • Monitoring and mitigation of perennial streams, riparian habitat, and wetlands as described under Water Resources and Geochemistry, Vegetation, and other Terrestrial Wildlife measures. |
| • Potential increase in mule deer mortalities from shifts in mule deer migration patterns. | • Fund mule deer habitat improvements, in consultation with the BLM and NDOW (maximum contribution $125,000).<br>• Funds for the acquisition and maintenance of alternative sources of water (e.g., guzzlers cisterns, purchase of water rights, etc.) (maximum contribution of $50,000). | | | • Reduction or loss of water in mule deer summer and transitional ranges, resulting in reduced carrying capacity and animal displacement.<br>• Reduction or loss of water in pronghorn summer and transitional ranges, resulting in reduced carrying capacity and animal displacement.<br>• Reduction in overall biodiversity.<br>• Animal displacement and incremental habitat fragmentation. | • Monitoring and mitigation of perennial streams, riparian habitat, and wetlands as described under Water Resources and Geochemistry, Vegetation, and other Terrestrial Wildlife measures.<br>• As discussed above, land use changes within the Squaw Valley Allotment would improve overall habitat conditions for riparian areas (also being considered for cumulative effects mitigation). |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| Impacts | Monitoring/Mitigation | Impacts | Monitoring/Mitigation | Impacts | Monitoring/ Mitigation |
| | | | | • Possible genetic isolation of localized, less mobile species dependent on affected riparian sites.<br>• Reduction in available water, riparian habitats, mesic areas, and potential nesting and brooding habitats for upland game birds. | |
| • Potential loss of raptor breeding habitat (e.g., red-tailed hawk), based on habitat loss and reduction of prey abundance. | • Monitoring and mitigation of riparian habitats, wetlands, and perennial streams, as discussed above. | | | • Potential reduction in prey base for predators, such as raptors, from reduced water levels and riparian habitats. | |
| • No anticipated impacts. | • None | | | • Gradual decrease in shorebirds and waterfowl in Boulder Valley, as surface water levels return to pre-mining levels and habitats return to upland communities. | • None |
| • No anticipated impacts. | • None | | | • As mine dewatering ends and soils dry in Boulder Valley, increased leaching of minerals and salts into the soil surface and subsurface layers, modifying associated plant communities. | • None |
| • Discharge of water into the unnamed drainage that flows into the TS Ranch Reservoir could change the amount, character, and duration of wildlife habitat along the unnamed drainage, around the reservoir, and in irrigated areas in Boulder Valley. | • Monitoring and mitigation of riparian habitats, wetlands, and perennial streams.<br>• Monitor creek channels and mitigate with channel armoring, as necessary. | | | • NA | • NA |
| *Pit Lake* | | | | | |
| • Lake predicted to have neutral pH; potential for elevated arsenic levels. | • Monitor post-mining pit lake water quality quarterly until at least 2030.<br>• Fund research on pit lake water quality ($50,000/year up to 10 years). | • NA | • NA | • Slight potential for short-term chronic impacts due to low pH. | • Monitoring and mitigation of riparian habitats, wetlands, and perennial streams as described under Water Resources and Geochemistry. |
| *Humboldt River Flow* | | | | | |
| | | • NA | • NA | • Increased flows in Humboldt River would result in improved maintenance and establishment of riparian vegetation in the short term.<br>• Increased river flows could improve water quality and quantity and riparian habitat for wildlife species. | • None |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| Impacts | Monitoring/Mitigation | Impacts | Monitoring/Mitigation | Impacts | Monitoring/ Mitigation |
| | | | | - Increased river flows could result in more open water during low-flow periods.<br>- Greater flows and water depths in the river and Humboldt Sink could limit use by breeding and foraging individuals, although other areas should become established.<br>- Increased flows in the Humboldt Sink would provide additional breeding, foraging, and resting areas for waterfowl and shorebirds.<br>- Increased flows in the Humboldt Sink would increase relative prey availability for area predators. | |
| *Humboldt River Water Quality* | | | | | |
| | | - NA | - NA | - Given existing data, additional mine discharges would not likely pose additional risks to wildlife in the Humboldt Sink beyond premining conditions. | - Continue aquatic biota monitoring study along Humboldt River and at Humboldt Sink, in cooperation with USFWS. |
| **AQUATIC RESOURCES** | | | | | |
| *Dewatering and Drawdown* | | | | | |
| - Dewatering activities would reduce habitat for aquatic biota in Boulder Creek drainage. | - None | - No dewatering impacts identified. | - Barrick shall prevent the introduction of nonnative aquatic species into TS Ranch Reservoir and other water bodies subject to their ownership or control. | - Dewatering activities could reduce habitat for native fish and other aquatic biota in Boulder Creek and upper Antelope Creek drainages. | - Continued monitoring of flows in perennial reaches of Boulder Creek and upper Antelope Creek drainages.<br>- If flow reductions occur, BLM would determine if mitigation should be required. Two options could be used:<br>1. Flow augmentation in affected perennial stream segments as outlined in Water Resources and Geochemistry.<br>2. Off-site enhancement involving improvements in land use practices in the Squaw Valley Allotmont (fencing to limit grazing near upper Rock, Toe Jam, and upper Willow creeks). (Also being considered for cumulative effects mitigation) |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| **Impacts** | **Monitoring/Mitigation** | **Impacts** | **Monitoring/Mitigation** | **Impacts** | **Monitoring/ Mitigation** |
| *Humboldt River Flow* | | | | | |
| | | • NA | • NA | • Dewatering discharges into Humboldt River would increase habitat for fish and other aquatic biota. | • None |
| **TERRESTRIAL SPECIAL STATUS SPECIES** | | | | | |
| Dewatering and Drawdown | | | | | |
| • Potential impacts to species associated with water sources and riparian or wetland vegetation could be affected by loss of seeps, springs, and perennial stream reaches. | • Monitor springs, seeps, riparian areas, and wetlands until at least 2030 (up to $250,000).<br>• Variety of monitoring points along perennial drainages.<br>• Monitor creek channels and mitigate with channel armoring, as necessary.<br>• Fund protection and enhancement of riparian and wetlands areas (maximum contributed $660,000).<br>• Fund post-dewatering revegetation of riparian and wetlands with seedlings or container plants (maximum of $40,000).<br>• Fund the acquisition and maintenance of alternative water sources (guzzlers, cisterns, etc.) (up to $50,000). May include (but not limited to) purchase of water rights at off-site locations or acquisition of wildlife easements to water sources.<br>• Long-term mitigation funds of $1,000,000 for review, monitoring, and mitigation of effects not specifically identified in EIS and not covered by reclamation plan. | • No dewatering impacts on terrestrial special status species were identified. | • Additional mitigation could be implemented for terrestrial species associated with riparian areas and streams if a review of ground water data indicates potential effects on surface flows. | • Potential impacts to special status species from incremental loss of available surface water, riparian vegetation, or wetlands. | • Monitoring and mitigation of perennial streams, riparian habitats, and wetlands as described under Water Resources and Geochemistry, Vegetation, and other Terrestrial Wildlife measures.<br>• Land use changes within the Squaw Valley Allotment would improve overall habitat conditions for special status species that utilize riparian communities and aquatic systems (also being considered for cumulative effects mitigation).<br>• BLM would review existing funds for adequacy and adjust if appropriate. |
| *Pit Lake* | | | | | |
| • See Terrestrial Wildlife. | • See Terrestrial Wildlife. | | | • Note: Potential impacts to wildlife from pit lake water quality would be the same for all species that use these areas. | • See Terrestrial Wildlife. |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| **Impacts** | **Monitoring/Mitigation** | **Impacts** | **Monitoring/Mitigation** | **Impacts** | **Monitoring/ Mitigation** |
| *Humboldt River Flow* | | | | | |
| • See Terrestrial Wildlife. | • See Terrestrial Wildlife. | | | • Note: Increased flows along the Humboldt River would result in short-term increase in water and riparian vegetation. | • None |
| *Humboldt River Water Quality* | | | | | |
| • See Terrestrial Wildlife. | • See Terrestrial Wildlife. | | | • Note: Potential impacts to wildlife from increased loading of metals in Humboldt Sink would be the same for all species that use these areas. | • Continue aquatic biota monitoring study along Humboldt River and at Humboldt Sink, in cooperation with USFWS. |
| **Preble's Shrew (if present)** | | | | | |
| • See general discussion for Terrestrial Special Status Species above. | • See general discussion for Terrestrial Special Status Species above. | | | • Long-term reduction in potential habitat. Short-term increase in potential habitat along Humboldt River. Potential exposure to constituents of concern at Humboldt Sink. | • Monitoring and mitigation of perennial streams, riparian habitats, and wetlands as described under Water Resources and Geochemistry, Vegetation, and other Terrestrial Wildlife measures. |
| | | | | | • Continue aquatic biota monitoring study along Humboldt River and at Humboldt Sink, in cooperation with USFWS. |
| **Long-eared Myotis,** Small-footed Myotis, **Spotted Bat** | | | | | |
| • See general discussion for Terrestrial Special Status Species above. | • See general discussion for Terrestrial Special Status Species above. | | | • Long-term reduction in potential foraging habitat. Short-term increase in potential foraging habitat along Humboldt River. Potential exposure to future pit lake water and constituents of concern at Humboldt Sink. | • Monitoring and mitigation of perennial streams, riparian habitats, and wetlands as described under Water Resources and Geochemistry, Vegetation, and other Terrestrial Wildlife measures. |
| | | | | | • Aquatic biota monitoring study along Humboldt River and at Humboldt Sink, in cooperation with USFWS. |
| **Long-legged Myotis, Fringed Myotis, Townsend's Big-eared Bat** | | | | | |
| • See general discussion for Terrestrial Special Status Species above. | • See general discussion for Terrestrial Special Status Species above. | | | • Same as for other three bat species discussed above. | • Same as for other three bat species discussed above. |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| Impacts | Monitoring/Mitigation | Impacts | Monitoring/Mitigation | Impacts | Monitoring/ Mitigation |
| **Bald Eagle, Golden Eagle, Swainson's Hawk, Ferruginous Hawk** | | | | | |
| • See general discussion for Terrestrial Special Status Species above. | • See general discussion for Terrestrial Special Status Species above. | | | • Long-term, incremental reduction in:<br>**Bald Eagle:** potential foraging habitat for wintering and migrating eagles.<br>**Golden Eagle:** potential foraging habitat and individual roost sites in riparian zones.<br>**Swainson's Hawk:** potential foraging and nesting habitat.<br>**Ferruginous Hawk:** potential foraging habitat.<br>**All Four Raptor Species:**<br>• Short-term increase in potential foraging habitat along Humboldt River. Potential exposure to future pit lake water and constituents of concern at Humboldt Sink. | **All Four Raptor Species:**<br>• Monitoring and mitigation of perennial streams, riparian habitats, and wetlands as described under Water Resources and Geochemistry, Vegetation, and other Terrestrial Wildlife measures.<br>**All Four Raptor Species:**<br>• Continue aquatic biota monitoring study along Humboldt River and at Humboldt Sink, in cooperation with USFWS. |
| **Northern Goshawk** | | | | | |
| • See general discussion for Terrestrial Special Status Species above. | • See general discussion for Terrestrial Special Status Species above. | | | • Long-term, incremental reduction in potential foraging and nesting habitat. Short-term increase in potential foraging habitat along Humboldt River for wintering birds. Potential exposure to future pit lake water and constituents of concern at Humboldt Sink. | • Monitoring and mitigation of perennial streams, riparian habitats, and wetlands as described under Water Resources and Geochemistry, Vegetation, and other Terrestrial Wildlife measures.<br>• Continue aquatic biota monitoring study along Humboldt River and at Humboldt Sink, in cooperation with USFWS. |
| **Burrowing Owl** | | | | | |
| • See general discussion for Terrestrial Special Status Species above. | • See general discussion for Terrestrial Special Status Species above. | | | • Long-term, incremental reduction in potential foraging habitat. Short-term increase in potential foraging habitat along Humboldt River. | • Monitoring and mitigation of perennial streams, riparian habitats, wetlands as described under Water Resources and Geochemistry, Vegetation, and other Terrestrial Wildlife measures. |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| **Impacts** | **Monitoring/Mitigation** | **Impacts** | **Monitoring/Mitigation** | **Impacts** | **Monitoring/ Mitigation** |
| **Sage Grouse** | | | | | |
| • See general discussion for Terrestrial Special Status Species above. | • See general discussion for Terrestrial Special Status Species above.<br>• Also, habitat improvement fund, as specified for Proposed Action.<br>• Fund $50,000 for sage grouse mitigation. | | | • Potential reduction in riparian and mesic communities, affecting the amount of potential brooding and foraging habitats for sage grouse. Habitat effects could alter sage grouse distribution and possibly reduce regional grouse population. | • In addition to existing restoration fund, monitoring and mitigation of perennial streams, riparian habitats, and wetlands as described under Water Resources and Geochemistry, Vegetation, and other Terrestrial Wildlife measures.<br>• To improve off-site sage grouse habitat, establish funds for habitat rehabilitation from past wildfire effects for native sagebrush lands. The amount of this fund would be negotiated between the BLM and Barrick.<br>• Improvement of habitat in Squaw Valley Allotment (also being considered for cumulative effects mitigation). |
| **American White Pelican, Osprey** | | | | | |
| • See general discussion for Terrestrial Special Status Species above. | • See general discussion for Terrestrial Special Status Species above. | | | • No impacts to lakes or reservoirs anticipated for both species. Short-term increase in potential foraging habitat along Humboldt River for osprey. Potential exposure to constituents of concern at Humboldt Sink for both species. | • Continue aquatic biota monitoring study along Humboldt River and at Humboldt Sink, in cooperation with USFWS. |
| **White-Faced Ibis, Black Tern** | | | | | |
| See general discussion for Terrestrial Special Status Species above. | • See general discussion for Terrestrial Special Status Species above. | | | • Long-term, incremental reduction in potential foraging and nesting habitat. Short-term increase in potential foraging habitat along Humboldt River. Potential exposure to constituents of concern at Humboldt Sink. | • Monitoring and mitigation of perennial streams, riparian habitats, and wetlands as described under Water Resources and Geochemistry, and Vegetation, and other Terrestrial Wildlife measures.<br>• Continue aquatic biota monitoring study along Humboldt River and at Humboldt Sink, in cooperation with USFWS. |
| | | | | • As mine dewatering ends and soils dry in Boulder Valley, increased leaching of minerals and salts into the soil surface and subsurface layers, modifying associated plant communities. | • None |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| Impacts | Monitoring/Mitigation | Impacts | Monitoring/Mitigation | Impacts | Monitoring/ Mitigation |
| Nevada Viceroy | | | | | |
| • See general discussion for Terrestrial Special Status Species above. | • See general discussion for Terrestrial Special Status Species above. | | | • Possible effects to potential habitat for Nevada viceroy. | • Monitoring and mitigation of perennial streams, riparian habitats, and wetlands as described under Water Resources and Geochemistry, and Vegetation, and other Terrestrial Wildlife measures. |
| AQUATIC SPECIAL STATUS SPECIES | | | | | |
| • No effects on aquatic species were identified. | • None | • No effects on aquatic species were identified. | • Barrick shall expand their network of monitoring surface water elevations in streams inhabited by LCT.<br>• Additional mitigation could be implemented for LCT, if a review of ground water data indicates effects on flows in streams inhabited by LCT.<br>• If monitoring data indicate that drawdown is expanding into streams inhabited by LCT, Barrick shall use reinjection wells to recharge the ground water system. | • Potential reductions in potential habitat for the spotted frog in upper Antelope Creek. | • Monitor flows in upper Antelope Creek (see measures described for Water Resources and Geochemistry). If flow reductions occur compared to baseflow conditions, BLM would determine the need for mitigation. Mitigation could involve off-site enhancement in the Squaw Valley Allotment (same as native fishes). |
| | | | | • Potential reductions in habitat and loss of individuals for springsnails in upper Antelope Creek and Squaw Creek. | • Conduct an inventory of springsnails in suitable habitat within previously unsurveyed seeps and springs in the potential impact area.<br>• Monitor flows in upper Antelope Creek and Squaw Creek (see Water Resources and Geochemistry). If reductions in flow or water levels occur compared to baseline conditions, BLM would determine the need for mitigation. Mitigation could involve flow augmentation, relocation of individuals, on-site enhancement, and off-site enhancement (fencing around seeps and springs). |

| Betze Project EIS (1991) | | Meikle Mine EA/BA (1994) | | Betze Project Supplemental EIS | |
|---|---|---|---|---|---|
| **Impacts** | **Monitoring/Mitigation** | **Impacts** | **Monitoring/Mitigation** | **Impacts** | **Monitoring/ Mitigation** |
| **GRAZING MANAGEMENT** | | | | | |
| • Potential flow reductions in seeps and springs could result in a loss of 345 acres of grazing land. | • Provide funds for acquisition and maintenance of alternative water sources (e.g., guzzlers, cisterns, purchase water rights, etc.) (maximum of $50,000). | | | • Possible effects on water sources in the Twenty-five and T Lazy S allotments. | • Continued annual monitoring of flows and water levels in representative seeps and springs within drawdown area.<br>• If water sources are lost, Barrick would make arrangements with BLM and landowners to replace water. |
| **SOCIOECONOMICS** | | | | | |
| • No anticipated impact. | • None | • No anticipated impact. | • None | • In unlikely event of Humboldt River discharge, minor increase in available irrigation water.<br>• Possible effects on grazing water sources.<br>• Possible effects to hunting and fishing activities. | • None<br>• See Grazing Management<br>• None |
| **NATIVE AMERICAN RELIGIOUS CONCERNS** | | | | | |
| • No anticipated impact. | • None | • No anticipated impact. | • None | • No anticipated impact. | • Consultation still in progress. Mitigation to be proposed if appropriate. |

[1] These measures may no longer be enforceable as the land associated with the Meikle Mine is no longer administered by the Bureau of Land Management.

## Table S-2

## Summary of Impacts and Monitoring/Mitigation for Proposed Action (Buried Pipeline)

| Impacts | Monitoring/ Mitigation Measures |
|---|---|
| **GEOLOGY** | |
| • No anticipated impact. | • None |
| **WATER RESOURCES AND GEOCHEMISTRY** | |
| • No anticipated impact. | • None |
| **VEGETATION (INCLUDING RIPARIAN)** | |
| • Pipeline construction would temporarily impact 18 acres of big sagebrush/grassland vegetation.<br>• Potential invasion of cheatgrass and halogeton in construction ROW. | • Reclamation and reseeding of disturbed area and continued noxious weed control. |
| **TERRESTRIAL WILDLIFE** | |
| • Temporary disturbance to 18 acres of big sagebrush/ grassland habitats. | • Reclamation of disturbed area by reseeding. Barrick's committed reclamation plan is in place; no additional monitoring or mitigation measures are proposed. |
| • Short-term animal displacement and possible loss of less mobile species (e.g., ground-nesting birds, small mammals, reptiles) from pipeline construction; however, no population-level effects anticipated. Loss of an active nest site would violate the Migratory Bird Treaty Act. | • Nest surveys or construction scheduling to avoid impacts to nesting birds. See Burrowing Owl under Terrestrial Special Status Species. |
| **AQUATIC RESOURCES** | |
| • No anticipated impact. | • None |
| **TERRESTRIAL SPECIAL STATUS SPECIES** | |
| • Note: Potential impacts to special status species from the Proposed Action are discussed below for each species. | • See below for applicable measures. |
| **Preble's Shrew (if present)** | |
| • Short-term reduction in potential habitat. | • None |
| **Long-eared Myotis, Small-footed Myotis, Spotted Bat** | |
| • No anticipated impact. | • None |
| **Long-legged Myotis, Fringed Myotis, Townsend's Big-eared Bat** | |
| • Short-term reduction in potential foraging habitat. | • None |
| **Bald Eagle, Golden Eagle, Swainson's Hawk, Ferruginous Hawk** | |
| **All Four Raptor Species:**<br>• Short-term reduction in potential upland foraging habitat. | • None |
| **Northern Goshawk** | |
| • No anticipated impact. | • None |

| Impacts | Monitoring/ Mitigation Measures |
|---|---|
| **Burrowing Owl** | |
| • Potential direct and indirect impacts to breeding adults, eggs, or young; short-term reduction in potential foraging habitat. | • If pipeline construction were to occur from March through August, a clearance survey would be conducted within 0.25 mile of the ROW for potentially active burrowing owl nests. If active nests were observed, Barrick would coordinate with the BLM to determine if protection measures are warranted (e.g., buffer area, constraint period, artificial nesting burrows, etc.). This determination would be based on variables, including breeding phenology, nest location, and type of construction activity. |
| **Sage Grouse** | |
| • Short-term reduction in potential breeding habitat. | • None |
| **American White Pelican, Osprey** | |
| • No anticipated impact. | • None |
| **White-Faced Ibis, Black Tern** | |
| • No anticipated impact. | • None |
| **Nevada Viceroy** | |
| • No anticipated impact. | • None |
| AQUATIC SPECIAL STATUS SPECIES | |
| • No ancitipated impact. | • None |
| GRAZING MANAGEMENT | |
| • Temporary loss of forage for livestock associated with 18 acres within the T Lazy S Allotment. | • Reclaim disturbed areas by reseeding. |
| AIR RESOURCES | |
| • Minor amounts of fugitive dust would be produced during the 2-week construction period. | • None |
| TOPOGRAPHY AND SOILS | |
| • No anticipated impact. | • None |
| LAND USE AND ACCESS | |
| • Increased irrigation water by approximately 8,000 gpm.<br>• In-place pipeline abandonment would encumber lands. | • None<br>• None |
| CULTURAL RESOURCES | |
| • No impacts to known cultural sites.<br>• Potential disturbance to unknown cultural sites in unsurveyed area. | • All previously unsurveyed sites would be examined prior to construction. Appropriate data recovery would be used for any identified sites in the ROW. |
| NATIVE AMERICAN RELIGIOUS CONCERNS | |
| • No anticipated impact. | • None |
| NOISE AND VISUAL RESOURCES | |
| • No exceedence of noise standards at sensitive receptors. | • None |
| • Reclamation of disturbed ROW would result in compatibility with VRM objectives. | • None |

# CONTENTS

SUMMARY ..... i

UNIT CONVERSION TABLE ..... xxxix

ACRONYMS AND ABBREVIATIONS ..... xl

1.0 INTRODUCTION ..... 1-1
- 1.1 Background ..... 1-1
- 1.2 Purpose and Need ..... 1-2
  - 1.2.1 Purpose and Need for the Proposed Action (Buried Pipeline) ..... 1-2
  - 1.2.2 Purpose and Need for the Supplemental EIS ..... 1-2
- 1.3 Issues ..... 1-2
- 1.4 Description of Barrick's Continuing Operations ..... 1-10
  - 1.4.1 Location and Land Ownership ..... 1-10
  - 1.4.2 Mining, Milling, and Beneficiation Operations ..... 1-10
    - 1.4.2.1 Betze-Post Mine ..... 1-13
    - 1.4.2.2 Meikle Mine ..... 1-15
    - 1.4.2.3 Rodeo and Goldbug Exploration ..... 1-15
    - 1.4.2.4 Heap Leach Facilities ..... 1-15
    - 1.4.2.5 Milling and Beneficiation Facilities ..... 1-15
  - 1.4.3 Water Management Operations ..... 1-16
    - 1.4.3.1 Wells and Collection System ..... 1-17
    - 1.4.3.2 TS Ranch Reservoir ..... 1-18
    - 1.4.3.3 Springs and Sand Dune Canal ..... 1-20
    - 1.4.3.4 Irrigation in Boulder Valley ..... 1-20
    - 1.4.3.5 Infiltration ..... 1-22
    - 1.4.3.6 Injection ..... 1-22
    - 1.4.3.7 Sand Dune Drainage Embankments ..... 1-22
    - 1.4.3.8 Humboldt River Discharge ..... 1-23
    - 1.4.3.9 Monitoring ..... 1-24
    - 1.4.3.10 Water Management Plans ..... 1-24
- 1.5 Water Management Alternatives ..... 1-25
  - 1.5.1 Additional Irrigation ..... 1-25
  - 1.5.2 Additional Infiltration or Injection ..... 1-25
  - 1.5.3 Discharge to Other Surface Waters ..... 1-25
  - 1.5.4 Other Water Uses ..... 1-26
- 1.6 Existing Mitigation Commitments - Betze Record of Decision ..... 1-26
  - 1.6.1 Monitoring Programs ..... 1-26
  - 1.6.2 Mitigation Measures ..... 1-27
- 1.7 Interrelated Projects ..... 1-27

## CONTENTS (Cont'd)

1.7.1 Water Management Operations ........ 1-28
1.7.1.1 Mining Operations ........ 1-28
1.7.1.2 Other Projects and Activities ........ 1-34
1.7.2 Proposed Action ........ 1-34
1.8 Relationship to Policies, Programs, and Plans ........ 1-34
1.9 Organization of this Supplemental EIS ........ 1-35

**2.0 PROPOSED ACTION AND ALTERNATIVES ........ 2-1**
2.1 Proposed Action (Buried Pipeline) ........ 2-1
2.2 Alternatives to the Proposed Action (No Action) ........ 2-1
2.3 Alternatives Considered but Eliminated from Detailed Analysis ........ 2-1
2.4 Agency Preferred Alternative ........ 2-3

**3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES FOR WATER MANAGEMENT OPERATIONS ........ 3-1**
3.1 Geology ........ 3-3
3.1.1 Affected Environment ........ 3-3
3.1.1.1 Physiographic and Topographic Setting ........ 3-3
3.1.1.2 Regional and Geographic Setting ........ 3-3
3.1.1.3 Faulting and Seismicity ........ 3-10
3.1.2 Environmental Consequences ........ 3-14
3.1.2.1 Impacts from Mine Dewatering and Localized Water Management Activities ........ 3-14
3.1.2.2 Impacts to the Humboldt River ........ 3-20
3.1.3 Monitoring and Mitigation ........ 3-20
3.1.4 Residual Impacts ........ 3-20
3.1.5 Irreversible and Irretrievable Commitment of Resources ........ 3-20
3.2 Water Resources and Geochemistry ........ 3-21
3.2.1 Affected Environment ........ 3-21
3.2.1.1 Introduction ........ 3-21
3.2.1.2 Hydrologic Study Area for Dewatering and Localized Water Management Activities ........ 3-27
3.2.1.3 Humboldt River Study Area ........ 3-57
3.2.2 Environmental Consequences ........ 3-81
3.2.2.1 Impacts from Mine Dewatering and Localized Water Management Activities ........ 3-82
3.2.2.2 Impacts to the Humboldt River ........ 3-116
3.2.3 Monitoring and Mitigation ........ 3-136
3.2.3.1 Mine Dewatering and Localized Water Management Activities ........ 3-136
3.2.3.2 Humboldt River Monitoring and Mitigation Measures ........ 3-139

## CONTENTS (Cont'd)

3.2.4 Residual Effects ........ 3-140
    3.2.4.1 Mine Dewatering and Localized Water Management Activities ........ 3-140
    3.2.4.2 Residual Effects to the Humboldt River ........ 3-140
3.2.5 Irreversible and Irretrievable Commitment of Resources ........ 3-140
3.3 Riparian Vegetation ........ 3-142
3.3.1 Affected Environment ........ 3-142
    3.3.1.1 Study Area for Mine Dewatering and Localized Water Management Activities ........ 3-142
    3.3.1.2 Humboldt River Study Area ........ 3-151
3.3.2 Environmental Consequences ........ 3-153
    3.3.2.1 Impacts from Mine Dewatering and Localized Water Management Activities ........ 3-153
    3.3.2.2 Impacts to the Humboldt River ........ 3-154
3.3.3 Monitoring and Mitigation ........ 3-156
3.3.4 Residual Effects ........ 3-157
3.3.5 Irreversible and Irretrievable Commitment of Resources ........ 3-157
3.4 Terrestrial Wildlife ........ 3-158
3.4.1 Affected Environment ........ 3-158
    3.4.1.1 Habitat ........ 3-158
    3.4.1.2 Game Species ........ 3-162
    3.4.1.3 Nongame Species ........ 3-168
3.4.2 Environmental Consequences ........ 3-170
    3.4.2.1 Overview ........ 3-170
    3.4.2.2 Impacts from Mine Dewatering and Localized Water Management Activities ........ 3-171
    3.4.2.3 Impacts Associated with the Pit Lake ........ 3-175
    3.4.2.4 Impacts to the Humboldt River ........ 3-176
    3.4.2.5 Impacts to the Humboldt Sink ........ 3-178
3.4.3 Monitoring and Mitigation ........ 3-187
3.4.4 Residual Effects ........ 3-187
3.4.5 Irreversible and Irretrievable Commitment of Resources ........ 3-187
3.5 Aquatic Resources ........ 3-188
3.5.1 Affected Environment ........ 3-188
    3.5.1.1 Boulder Creek Subbasin ........ 3-188
    3.5.1.2 Maggie Creek Subbasin ........ 3-188
    3.5.1.3 Rock Creek Subbasin ........ 3-190
    3.5.1.4 Humboldt River Basin ........ 3-191
3.5.2 Environmental Consequences ........ 3-193
    3.5.2.1 Impacts from Mine Dewatering and Localized Water Management Activities ........ 3-193

## CONTENTS (Cont'd)

3.5.2.2 Impacts to the Humboldt River ........ 3-193
3.5.3 Monitoring and Mitigation ........ 3-195
3.5.4 Residual Impacts ........ 3-195
3.5.5 Irreversible and Irretrievable Commitment of Resources ........ 3-195
3.6 Threatened, Endangered, Candidate, and Sensitive Species ........ 3-196
3.6.1 Affected Environment ........ 3-196
3.6.1.1 Terrestrial Species ........ 3-196
3.6.1.2 Aquatic Species ........ 3-202
3.6.2 Environmental Consequences ........ 3-210
3.6.2.1 Terrestrial Species ........ 3-210
3.6.2.2 Aquatic Species ........ 3-215
3.6.3 Monitoring and Mitigation ........ 3-216
3.6.3.1 Sage Grouse ........ 3-216
3.6.3.2 Spotted Frog ........ 3-216
3.6.3.3 Springsnails ........ 3-216
3.6.4 Residual Effects ........ 3-217
3.6.5 Irreversible and Irretrievable Commitment of Resources ........ 3-217
3.7 Grazing Management ........ 3-218
3.7.1 Affected Environment ........ 3-218
3.7.2 Environmental Consequences ........ 3-221
3.7.2.1 Impacts from Mine Dewatering and Localized Water Management Activities ........ 3-221
3.7.2.2 Impacts to the Humboldt River ........ 3-227
3.7.3 Monitoring and Mitigation ........ 3-227
3.7.4 Residual Effects ........ 3-227
3.7.5 Irreversible and Irretrievable Commitment of Resources ........ 3-227
3.8 Socioeconomics ........ 3-228
3.9 Native American Religious Concerns ........ 3-229
3.10 Environmental Justice ........ 3-230
3.11 Relationship Between Short-Term Uses of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity ........ 3-232

4.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION ........ 4-1
4.1 Air Quality ........ 4-1
4.1.1 Affected Environment ........ 4-1
4.1.2 Environmental Consequences ........ 4-2
4.1.2.1 Proposed Action ........ 4-2
4.1.2.2 No Action ........ 4-2
4.2 Topography and Soils ........ 4-2

## CONTENTS (Cont'd)

4.2.1 Affected Environment ... 4-2
4.2.2 Environmental Consequences ... 4-2
4.2.2.1 Proposed Action ... 4-2
4.2.2.2 No Action ... 4-2
4.3 Water Resources ... 4-2
4.3.1 Affected Environment ... 4-2
4.3.2 Environmental Consequences ... 4-3
4.3.2.1 Proposed Action ... 4-3
4.3.2.2 No Action ... 4-3
4.4 Vegetation, Including Threatened, Endangered, Candidate, or Sensitive Species ... 4-3
4.4.1 Affected Environment ... 4-3
4.4.2 Environmental Consequences ... 4-3
4.4.2.1 Proposed Action ... 4-3
4.4.2.2 No Action ... 4-3
4.5 Wildlife and Aquatic Resources ... 4-3
4.5.1 Affected Environment ... 4-3
4.5.2 Environmental Consequences ... 4-5
4.5.2.1 Proposed Action ... 4-5
4.5.2.2 No Action ... 4-6
4.6 Threatened, Endangered, Candidate, or Sensitive Wildlife Species ... 4-6
4.6.1 Affected Environment ... 4-6
4.6.2 Environmental Consequences ... 4-6
4.6.2.1 Proposed Action ... 4-6
4.6.2.2 No Action ... 4-7
4.7 Grazing Management ... 4-7
4.7.1 Affected Environment ... 4-7
4.7.2 Environmental Consequences ... 4-7
4.7.2.1 Proposed Action ... 4-7
4.7.2.2 No Action ... 4-7
4.8 Access and Land Use ... 4-7
4.8.1 Affected Environment ... 4-7
4.8.2 Environmental Consequences ... 4-7
4.8.2.1 Proposed Action ... 4-7
4.8.2.2 No Action ... 4-8
4.9 Cultural Resources ... 4-8
4.9.1 Affected Environment ... 4-8
4.9.1.1 Cultural Resources Identified in the Project Area ... 4-8
4.9.1.2 Native American Concerns ... 4-8
4.9.2 Environmental Consequences ... 4-8
4.9.2.1 Proposed Action ... 4-8

## CONTENTS (Cont'd)

4.9.2.2 No Action ..... 4-9
4.10 Visual Resources ..... 4-9
4.10.1 Affected Environment ..... 4-9
4.10.2 Environmental Consequences ..... 4-9
4.10.2.1 Proposed Action ..... 4-9
4.10.2.2 No Action ..... 4-9
4.11 Mitigation Measures ..... 4-9
4.12 Residual Effects ..... 4-10
4.13 Irreversible and Irretrievable Commitment of Resources ..... 4-10
4.14 Relationship Between Short-Term Uses of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity ..... 4-10

**5.0 CUMULATIVE IMPACTS ..... 5-1**
5.1 Geology ..... 5-1
5.1.1 Mine Dewatering and Localized Water Management Activities ..... 5-1
5.1.2 Humboldt River ..... 5-3
5.1.3 Proposed Action and No Action Alternative ..... 5-3
5.2 Water Resources and Geochemistry ..... 5-3
5.2.1 Mine Dewatering and Localized Water Management Activities ..... 5-4
5.2.1.1 Impacts to Ground Water Levels ..... 5-4
5.2.1.2 Impacts to Perennial Springs and Streams ..... 5-9
5.2.1.3 Impacts to Ground Water Rights ..... 5-9
5.2.1.4 Impacts to Surface Water Rights ..... 5-9
5.2.1.5 Impacts to the Regional Ground Water Balance ..... 5-9
5.2.2 Humboldt River ..... 5-13
5.2.3 Proposed Action and No Action Alternative ..... 5-19
5.3 Riparian Vegetation ..... 5-19
5.3.1 Mine Dewatering and Localized Water Management Activities ..... 5-19
5.3.1.1 Maggie Creek Watershed ..... 5-20
5.3.1.2 Rock Creek Watershed ..... 5-20
5.3.1.3 Susie Creek Watershed ..... 5-20
5.3.1.4 Small Tributaries to the Humboldt River ..... 5-20
5.3.1.5 Humboldt River ..... 5-20
5.3.1.6 Isolated Springs and Seeps ..... 5-20
5.3.2 Humboldt River ..... 5-21
5.3.3 Proposed Action and No Action Alternative ..... 5-22
5.4 Terrestrial Wildlife ..... 5-22
5.4.1 Mine Dewatering and Localized Water Management Activities ..... 5-22
5.4.2 Humboldt River ..... 5-23
5.4.3 Proposed Action and No Action Alternative ..... 5-24

## CONTENTS (Cont'd)

5.5 Aquatic Resources ..... 5-24
  5.5.1 Mine Dewatering and Localized Water Management Activities ..... 5-24
  5.5.2 Humboldt River ..... 5-25
  5.5.3 Proposed Action and No Action Alternative ..... 5-25
5.6 Threatened, Endangered, Candidate, and Sensitive Species ..... 5-25
  5.6.1 Terrestrial Species ..... 5-25
  5.6.2 Aquatic Species ..... 5-28
5.7 Grazing Management ..... 5-29
  5.7.1 Mine Dewatering and Localized Water Management Activities ..... 5-29
    5.7.1.1 Twenty-five Allotment ..... 5-30
    5.7.1.2 T Lazy S Allotment ..... 5-30
    5.7.1.3 Hadley Allotment ..... 5-30
    5.7.1.4 Carlin Field Allotment ..... 5-31
    5.7.1.5 McKinley Allotment ..... 5-31
    5.7.1.6 Marys Mountain Allotment ..... 5-31
  5.7.2 Humboldt River ..... 5-31
  5.7.3 Proposed Action and No Action Alternative ..... 5-31
5.8 Socioeconomics ..... 5-31
  5.8.1 Mine Dewatering and Localized Water Management Activities ..... 5-32
    5.8.1.1 Lowered Water Levels in Wells ..... 5-32
    5.8.1.2 Reduced Flow in Springs ..... 5-32
    5.8.1.3 Reduced Streamflow ..... 5-33
    5.8.1.4 Geology and Minerals ..... 5-33
  5.8.2 Humboldt River ..... 5-33
    5.8.2.1 Increased River Flow ..... 5-33
    5.8.2.2 Reduced River Flow ..... 5-34
    5.8.2.3 Water Quality Impacts ..... 5-34
  5.8.3 Proposed Action and No Action Alternative ..... 5-34
5.9 Native American Religious Concerns ..... 5-34
  5.9.1 Impacts to Plants ..... 5-35
  5.9.2 Impacts to Animals ..... 5-35
  5.9.3 Impacts to Water ..... 5-36
  5.9.4 Impacts to Traditional Cultural Properties, Grave Sites, and Historic Sites ..... 5-37
  5.9.5 Impacts to Traditional Religious Practices and Cosmology ..... 5-37
5.10 Cultural Resources ..... 5-38
5.11 Air Quality ..... 5-38
5.12 Topography and Soils ..... 5-38
5.13 Access and Land Use ..... 5-39
5.14 Visual Resources ..... 5-39

## CONTENTS (Cont'd)

6.0 CONSULTATION AND COORDINATION .......... 6-1
  6.1 Introduction .......... 6-1
  6.2 Implementation .......... 6-1
  6.3 Criteria and Methods by Which Public Input is Evaluated .......... 6-2
  6.4 Consultation with Others .......... 6-2
  6.5 Draft SEIS Review .......... 6-3

7.0 LIST OF PREPARERS AND REVIEWERS .......... 7-1

8.0 REFERENCES .......... 8-1

GLOSSARY .......... G-1

INDEX .......... I-1

APPENDIX A - WATER RIGHTS

APPENDIX B - WATER QUALITY

APPENDIX C - HUMBOLDT RIVER INFORMATION

APPENDIX D - SUMMARY OF THE BARRICK HYDROLOGIC MODEL

APPENDIX E - WATERFOWL DATA

APPENDIX F - AQUATIC RESOURCES TABLES

## LIST OF TABLES

**1-1** Issues and Concerns Identified in Scoping ........ 1-3
**1-2** Permits Currently Authorized at the Goldstrike Mine ........ 1-13
**1-3** Goldstrike Property Mining Plans Through the Year 2004 ........ 1-16
**1-4** Dewatering and Water Management Summary Table ........ 1-29
**1-5** Humboldt River Discharge Summary ........ 1-31
**2-1** Seed Mixture ........ 2-3
**3.1-1** Generalized Description of the Regional Geologic Map Units ........ 3-7
**3.1-2** Basin Characteristics ........ 3-11
**3.1-3** Effects of Geologic Events on Rock Properties ........ 3-11
**3.2-1** Major Subregions Within the Hydrologic Study Area ........ 3-22
**3.2-2** Mean Annual Precipitation (inches) ........ 3-27
**3.2-3** Summary of Hydrostratigraphic Unit Hydraulic Properties ........ 3-28
**3.2-4** Pre-1991 Estimated Ground Water Budget ........ 3-35
**3.2-5** General Flow Characteristics, Humboldt River Tributaries ........ 3-40
**3.2-6** Drinking Water Standards Applicable to Ground Water ........ 3-47
**3.2-7** Summary of Ground Water Chemistry by Hydrostratigraphic Unit ........ 3-49
**3.2-8** General Seasonal Irrigation Demand Estimates ........ 3-59
**3.2-9** Areas Upstream of Humboldt River Gages ........ 3-62
**3.2-10** Average Annual Humboldt River Flows ........ 3-65
**3.2-11** Average June Humboldt River Flows ........ 3-65
**3.2-12** Average September Humboldt River Flows ........ 3-65
**3.2-13** Mean Annual Humboldt River Gains and Losses ........ 3-66
**3.2-14** Mean October Gains and Losses in the Humboldt River ........ 3-67
**3.2-15** Historical Changes in Humboldt River Configuration ........ 3-70
**3.2-16** Humboldt River Channel Sinuosity Over Time, Dunphy to Mosel ........ 3-70
**3.2-17** Major Conveyance Structures Within the Humboldt River Study Area ........ 3-74
**3.2-18** Approximate Five-county Acreage with Humboldt River Water Rights, and Annually Decreed and Permitted Water on the Lower River ........ 3-78
**3.2-19** Water Quality Standards for the Humboldt River at Palisade and Woolsey Control Points .. 3-79
**3.2-20** Humboldt River Water Quality ........ 3-80
**3.2-21** Elevations of the Regional Ground Water System, Drawdown, and Mounding at Selected Timeframes ........ 3-85
**3.2-22** Springs Located Within or Near the Predicted Drawdown Area ........ 3-93
**3.2-23** Ground Water Rights and Application for Ground Water Rights Located Within the Predicted Drawdown Area ........ 3-104
**3.2-24** Surface Water Rights Located Within the Predicted Drawdown Area ........ 3-107
**3.2-25** Median Predicted Betze-Post Pit Lake Chemical Concentrations ........ 3-114
**3.2-26** Modeled Maximum Goldstrike Mine Discharges to the Humboldt River ........ 3-120

## LIST OF TABLES (Cont'd)

**3.2-27** Potential Changes in River Stages from Projected Maximum Goldstrike Mine Discharges ........ 3-125
**3.3-1** Acres of Riparian and Wetland Vegetation in the Study Area ........ 3-143
**3.3-2** Wetland and Riparian Vegetation Types and Dominant Species in the Study Area ........ 3-147
**3.3-3** Vegetation Associated with Seeps and Springs ........ 3-151
**3.4-1** Highest (from 10 to 233 years) Median Pit Lake Water Concentrations and Benchmark NOAELs for Water Ingestion ........ 3-177
**3.4-2** Surface Water, Sediment, and Tissue Concentrations of Constituents of Concern from Humboldt Lake (1987-1990) ........ 3-181
**3.4-3** Mean Surface Water Concentrations Measured in Humboldt Lake and Threshold Effects Levels from the Literature ........ 3-183
**3.4-4** Mean Tissue Concentrations Measured in Organisms Collected in Humboldt Lake and Threshold Effects Levels from the Literature ........ 3-183
**3.4-5** NOAELS from Laboratory Studies Used to Estimate Risks to Wildlife ........ 3-185
**3.4-6** Estimated Concentrations of Select Constituents in Water Entering the Humboldt Sink ........ 3-186
**3.6-1** Special Status Species Identified for the Betze Project Supplemental EIS ........ 3-197
**3.6-2** Estimated Miles of Occupied LCT Habitat in the Maggie Creek and Rock Creek Subbasins ........ 3-203
**3.6-3** Mean LCT Abundance (number/mile) in the Beaver Creek Drainage, 1994 ........ 3-206
**3.6-4** Summary of LCT Densities in Maggie Creek Tributaries, 1997 ........ 3-206
**3.6-5** LCT Densities for Rock Creek Subbasin Tributaries ........ 3-207
**3.7-1** Grazing Allotments in the Study Area ........ 3-219
**3-7.2** Water-related Range Improvements Within the 10-foot Drawdown Contour ........ 3-225
**5-1** Summary of Springs Within the Predicted Cumulative Drawdown Area ........ 5-10
**5-2** Summary of Ground Water Rights Within the Cumulative Drawdown Area ........ 5-10
**5-3** Summary of Surface Water Rights Within the Cumulative Drawdown Area ........ 5-12
**5-4** Projected Maximum Decreases in Humboldt River Flow Resulting from Cumulative Drawdown ........ 5-19

## LIST OF FIGURES

1-1 General Location Map ........ 1-11
1-2 Surface Management Status ........ 1-12
1-3 Goldstrike Property Facilities ........ 1-14
1-4 Water Operations Components ........ 1-19
1-5 Recent Springs and Associated Wetlands ........ 1-21
1-6 Basin Boundaries and Humboldt River Features ........ 1-33
2-1 Proposed Action – Buried Pipeline Location ........ 2-2
3.1-1 Regional Topographic Map ........ 3-4
3.1-2 Regional Geologic Map ........ 3-5
3.1-3 Regional Geologic Cross Sections ........ 3-6
3.1-4 Project Area Geologic Map ........ 3-9
3.1-5 Quaternary Faults in Nevada ........ 3-12
3.1-6 Quaternary Faults and Seismic Events ........ 3-13
3.1-7 Block Diagrams of Sinkhole Development ........ 3-15
3.1-8 Solution and Fracture Features Identified as of December 1998 ........ 3-17
3.1-9 Areas Potentially Susceptible to Sinkhole Development ........ 3-19
3.2-1 Hydrologic Study Area for Mine Dewatering and Localized Water Management Activities ........ 3-23
3.2-2 Relation of Mean Annual Precipitation to Altitude ........ 3-24
3.2-3 Average Monthly Precipitation at Elko and Battle Mountain ........ 3-25
3.2-4 Annual Precipitation at Elko and Battle Mountain ........ 3-26
3.2-5 Major Hydrostructural Features ........ 3-31
3.2-6 Hydrogeologic Cross Section Through Ranch Dam and Betze-Post Pit ........ 3-32
3.2-7 Unconfined Ground Water Levels, 1990-1991 ........ 3-34
3.2-8 Ground Water Rights, Application for Ground Water Rights and Other Known Wells in the Hydrologic Study Area ........ 3-37
3.2-9 Areas of Perennial Stream Reaches, Springs, and Seeps in the Hydrologic Study Area .. 3-38
3.2-10 Streamflow Measurement Sites, Humboldt River Tributaries ........ 3-41
3.2-11 Surface Water Rights, and Application for Surface Water Rights in the Hydrologic Study Area ........ 3-46
3.2-12 Selected Regional Water Quality Monitoring Wells ........ 3-48
3.2-13 Piper Trilinear Diagram of Baseline Ground Water Chemistry ........ 3-51
3.2-14 Stream Classification for Beneficial Uses and Associated Standards ........ 3-55
3.2-15 Stream Sampling Sites with Summarized Water Quality Data ........ 3-56
3.2-16 Rye Patch and Pitt-Taylor Reservoirs ........ 3-60
3.2-17 Long-Term Average Annual Streamflows for the Humboldt River at USGS Gage Stations ........ 3-64
3.2-18 Humboldt River Sediment Discharges ........ 3-68

## LIST OF FIGURES (CONT'D)

**3.2-19** Historic Channel Migration Along a Portion of the Humboldt River .................................. 3-73
**3.2-20** Humboldt and Carson Sinks Area ................................................................ 3-76
**3.2-21** Barrick Pumping Rate ................................................................ 3-83
**3.2-22** Drawdown and Mounding, End of 1998 ................................................................ 3-84
**3.2-23** Predicted Drawdown at End of Mining ................................................................ 3-87
**3.2-24** Predicted Drawdown at 50 Years Postmining ................................................................ 3-88
**3.2-25** Predicted Drawdown at 100 Years Postmining ................................................................ 3-89
**3.2-26** Predicted Drawdown at Recovery ................................................................ 3-90
**3.2-27** 1998 Drawdown Relative to Annual Spring and Stream Monitoring Sites .......................... 3-92
**3.2-28** Boulder Valley Spring Flow Areas ................................................................ 3-99
**3.2-29** Potentially Impacted Perennial Waters Within the 10-foot Drawdown Area ..................... 3-101
**3.2-30** Potential Drawdown Impacts to Ground Water Rights, Application for Ground Water Rights, and Other Known Wells ................................................................ 3-103
**3.2-31** Potential Drawdown Impacts to Surface Water Rights and Application for Surface Water Rights ................................................................ 3-106
**3.2-32** Total Dissolved Solids and Dissolved Arsenic Over Time for the New Springs in Boulder Valley ................................................................ 3-109
**3.2-33** Estimated Final Betze-Post Pit Lake ................................................................ 3-112
**3.2-34** Betze-Post Pit Lake Trends in Median Predicted Chemical Concentrations .................... 3-115
**3.2-35** Goldstrike Mine Discharges to the Humboldt River ................................................................ 3-117
**3.2-36** Projected Changes to Flows at Battle Mountain ................................................................ 3-122
**3.2-37** Projected Changes to Flows at Comus ................................................................ 3-123
**3.2-38** Estimated Average Annual Premine Loads at the Carlin and Rye Patch Gages ............. 3-130
**3.2-39** Potential Maximum Increases in Annual Loads of TDS and Arsenic at the Rye Patch Gage ................................................................ 3-132
**3.2-40** Potential Maximum Increases in Annual Loads of Boron and Fluoride at the Rye Patch Gage ................................................................ 3-133
**3.2-41** Potential Maximum Increases in Annual Loads of Copper and Zinc at the Rye Patch Gage ................................................................ 3-134
**3.2-42** Total Potential Increase in Loads During the Mine Discharge Period (1997-2011) at Rye Patch Gage ................................................................ 3-135
**3.2-43** Comparison of Average Annual Loads at Rye Patch Gage vs. Humboldt Sink (Premine Discharge) ................................................................ 3-137
**3.2-44** Total Potential Increase in Loads During the Mine Discharge Period at the Humboldt Sink ................................................................ 3-138
**3.3-1** Riparian Areas in the Hydrologic Study Area ................................................................ 3-146
**3.3-2** Riparian Areas Potentially Affected by Drawdown ................................................................ 3-155
**3.4-1** Mule Deer Designated Seasonal Ranges ................................................................ 3-163
**3.4-2** Pronghorn Designated Seasonal Ranges ................................................................ 3-165

## LIST OF FIGURES (CONT'D)

**3.4-3** California Bighorn Sheep Designated Range ........ 3-166
**3.6-1** Current Distribution of Lahontan Cutthroat Trout ........ 3-204
**3.6.2** Known Locations for Springsnail Populations and Spotted Frog Habitat ........ 3-209
**3.7-1** Grazing Allotments and Pastures ........ 3-222
**3.7-2** Grazing Allotments and Water-related Range Improvements ........ 3-223
**3.7-3** Perennial Waters Within Grazing Allotments Potentially Affected by Drawdown ........ 3-224
**4-1** Proposed Action - Right-of-Way Location ........ 4-4
**5-1** Areas Potentially Susceptible to Sinkhole Development ........ 5-2
**5-2** Current Drawdown and Mounding (End of 1998) ........ 5-5
**5-3** Predicted Maximum Extent of the Cumulative 10-Foot Drawdown Contour ........ 5-7
**5-4** Comparison of the Predicted Goldstrike Mine Drawdown Area and the Cumulative Drawdown Area ........ 5-8
**5-5** Potentially Impacted Perennial Waters Within the Cumulative Drawdown Area ........ 5-11
**5-6** Cumulative Mining Discharges to the Humboldt River ........ 5-14
**5-7** Projected Changes to Flows at Battle Mountain ........ 5-15
**5-8** Projected Changes to Flows at Comus ........ 5-16
**5-9** Potential Cumulative Increase in Loads During the Mine Discharge Period at the Humboldt Sink ........ 5-18

# UNIT CONVERSION TABLE

| From | To | Multiply By |
|---|---|---|
| **Area** | | |
| acres | square feet | 43,560 |
| square miles | acres | 640 |
| **Volume** | | |
| acre-feet | gallons | 325,829 |
| gallons | cubic feet | 7.48 |
| **Flow** | | |
| cubic feet per second (cfs) | gallons per minute (gpm) | 449 |
| gpm | acre-feet per year | 1.61 |
| cfs | acre-feet per year | 724 |
| **Concentration** | | |
| parts per million (ppm) | milligrams per liter (mg/L) | 1 |
| mg/L | micrograms per liter (µg/L) | 1000 |
| **Loads** | | |
| tons per day (tpd) | tons per year (tpy) | 365 |
| tpy | pounds per day | 5.48 |

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| °F | Fahrenheit |
| µg/g | micrograms per gram |
| µg/L | micrograms per liter |
| ALNINC | *Alnus incana* |
| amsl | above mean sea level |
| ANFO | ammonium nitrate fuel oil |
| AUM | animal unit month |
| BLM | Bureau of Land Management |
| BVMP | Boulder Valley Monitoring Plan |
| bw | body weight |
| CEQ | Council on Environmental Quality |
| CFR | Code of Federal Regulations |
| cfs | cubic feet per second |
| CIA | Cumulative Impact Analysis |
| CO | carbon monoxide |
| CTQ | Community Tolerance Quotient |
| EIS | environmental impact statement |
| ELLCO | Elko Land and Livestock Company |
| EPA | Environmental Protection Agency |
| ET | evapotranspiration |
| FFR | Fenced Federal Range |
| FLPMA | Federal Land Policy and Management Act of 1976 |
| gpm | gallons per minute |
| $H_2S$ | hydrogen sulfide |
| LCT | Lahonton cutthroat trout |
| LMC | Lower Maggie Creek |
| LOAEL | Lowest Observed Adverse Effects Levels |
| $m^2$ | square meters |
| MCBMP | Maggie Creek Basin Monitoring Plan |
| MCWRP | Maggie Creek Watershed Restoration Project |
| mg/kg | milligrams/kilograms |
| mg/L | milligrams per liter |
| Na | sodium |
| NAAQS | National Ambient Air Quality Standards |
| NAC | Nevada Administrative Code |
| NaCl | sodium chloride |
| NDCNR | Nevada Department of Conservation and Natural Resources |
| NDEP | Nevada Department of Environmental Protection |
| NDOW | Nevada Division of Wildlife |
| NDWR | Nevada Department of Water Resources |
| NEPA | National Environmental Policy Act |
| NNHP | Nevada Natural Heritage Program |

| | |
|---|---|
| $NO_2$ | oxides of nitrogen |
| NOAA | National Oceanographic and Atmospheric Administration |
| NOAEL | No Observed Adverse Effects Levels |
| NOI | Notice of Intent |
| NPDES | National Pollutant Discharge Elimination System |
| NRCS | Natural Resources Conservation Service |
| NRHP | National Register of Historic Places |
| NRS | Nevada Revised Statute |
| NTU | nephelometric turbidity units |
| OHWM | ordinary high water mark |
| $PM_{10}$ | particulate matter with an aerodynamic diameter of 10 microns or less |
| ROW | right-of-way |
| RTi | Riverside Technology, inc. |
| SAR | sodium adsorption ratio |
| SHPO | State Historic Preservation Officer |
| $SO_2$ | sulfur dioxide |
| $SO_4$ | sulfate |
| SOAP | South Operations Area Project |
| SOAPA | South Operations Area Project Amendment |
| TDS | total dissolved solids |
| TSS | total suspended solids |
| UIC | underground injection control (permit) |
| USCOE | U.S. Army Corps of Engineers |
| USEPA | U.S. Environmental Protection Agency |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Survey |
| VRM | Visual Resource Management |
| WMA | Wildlife Management Area |

# 1.0 INTRODUCTION

## 1.1 Background

Barrick Goldstrike Mines Inc. (Barrick) owns and operates the Goldstrike property, which is located in Elko and Eureka Counties, Nevada, approximately 23 miles northwest of Carlin, Nevada. In 1989, Barrick submitted a Plan of Operations (Plan) pursuant to the Surface Management Regulations, 43 Code of Federal Regulations (CFR) Part 3809, to the Bureau of Land Management (BLM) for the Betze Project. As provided by Section 102(c) of the National Environmental Policy Act of 1969, as amended (NEPA), BLM prepared an environmental impact statement (EIS) with respect to Barrick's proposed Plan. The Final EIS and Record of Decision for the Betze Project were issued on June 10, 1991. The Final EIS included a description of the environmental impacts projected to result from ground water pumping to be conducted by Barrick to lower the local ground water elevations below the proposed Betze mining operations.

Since the Betze EIS was issued, Barrick's implementation of the ground water pumping and management operations and its monitoring of ground water elevations have provided new information regarding the pumping requirements and potential environmental impacts of Barrick's ground water pumping operations. Upon noting that dewatering rates and hydrologic conditions were substantially different from those anticipated in the June 1991 Final EIS and Record of Decision for the Betze Project, the BLM raised concerns about the environmental impacts in a letter to Barrick dated December 17, 1992. By letter of December 22, 1992, Barrick agreed to underwrite the reasonable cost of conducting an analysis of the potential impacts of Barrick's dewatering operations. Barrick also proposed to use the analysis as a means to define implementation programs for appropriate mitigation measures in keeping with the Betze Project Record of Decision. The BLM prepared this Supplemental EIS to address these issues and concerns.

Also, in July 1996 the Nevada Division of Environmental Protection (NDEP) issued a National Pollutant Discharge Elimination System (NPDES) Permit, NPDES Permit NV0022675, to Barrick authorizing the discharge of up to 70,000 gallons of water per minute (gpm) to the Humboldt River. Barrick completed construction of a treatment plant and conveyance system on private land in August 1997 and began discharging water to the Humboldt River in September 1997 as irrigation demand declined.

Finally, in May 1997 Barrick and Elko Land and Livestock Company (ELLCO) submitted an application to the BLM to amend an existing right-of-way to authorize the installation of an additional buried pipeline across public domain land administered by the BLM, as part of the existing water conveyance system. Installation of the additional buried pipeline would enhance the operational flexibility of the water distribution system established in Boulder Valley by Barrick and ELLCO.

This Supplemental EIS evaluates the environmental effects of Barrick's ongoing water management operations and of installing a second pipeline across public lands. Installation of the buried pipeline is the Proposed Action addressed in this Supplemental EIS and is the Proposed Action upon which the BLM will make a decision.

Barrick's current and anticipated future ground water pumping and water management operations are described in detail in Section 1.4. The Proposed Action, i.e., the buried pipeline, is described in Section 2.1.

The BLM recently prepared a Cumulative Impact Analysis (CIA) report (BLM 2000b) to address potential cumulative dewatering and discharge impacts associated with Barrick's Betze Project and Newmont Gold Company's (Newmont's) proposed South Operations Area Project Amendment and Leeville Project. This CIA may result in the implementation of mitigation measures to address the cumulative impacts of the ground water pumping and water management operations of these three mines. The BLM will identify monitoring programs and mitigation measures in conjunction with the affected parties; monitoring and mitigation measures will be specified in the Final EISs for the three projects.

## 1.2 Purpose and Need

### 1.2.1 Purpose and Need for the Proposed Action (Buried Pipeline)

Approval of the amended right-of-way and installation of the proposed buried pipeline would: (1) enhance the operational flexibility of the water distribution system established in Boulder Valley by Barrick and ELLCO; (2) eliminate the need to treat a portion of the ground water delivered to irrigation uses on ELLCO's property; and (3) increase the quantity of water that could be delivered to irrigation uses. As described in Section 2.1, the proposed pipeline would enable Barrick to separate water that meets the water quality criteria of its NPDES Permit from water that can be used for irrigation without treatment. The capability to separate these flows would result in an increase in the availability of water for irrigation or for infiltration into Boulder Valley. This flexibility in handling would decrease or eliminate the amount of water discharged to the Humboldt River and thus removed from the hydrographic area in addition to decreasing treatment costs.

### 1.2.2 Purpose and Need for the Supplemental EIS

The purpose and need for the Supplemental EIS are to: (1) update the environmental analysis of Barrick's ground water pumping and water management operations that was conducted in the Betze Project EIS, based on additional data and other information collected since 1991 (see Chapter 3.0); and (2) analyze the environmental impacts associated with issuance of an amended right-of-way by BLM authorizing the construction and operation of a 3,936-foot buried pipeline across public lands (see Chapter 4.0).

## 1.3 Issues

The BLM is serving as lead agency in preparing this Supplemental EIS. Preparation of the Supplemental EIS is consistent with BLM's NEPA guidance, BLM Handbook H-1790-1, and the Council on Environmental Quality's (CEQ) NEPA regulations. The BLM published a Notice of Intent to prepare the Supplemental EIS for Barrick's ground water pumping and water management operations in the Federal Register on August 31, 1994, and mailed a Dear Interested Party letter dated September 2, 1994, announcing the preparation of the Supplemental EIS to 465 people. The BLM held scoping meetings in Elko and Reno, Nevada on September 14 and 15, 1994, respectively. The BLM received 11 written and 9 oral comments during the scoping period for the Supplemental EIS.

Following receipt of Barrick's and ELLCO's application to amend the right-of-way for the proposed buried pipeline, the BLM published a second Notice of Intent in the Federal Register on January 7, 1998, and mailed a second Dear Interested Party letter dated January 14, 1998, to 284 people. In response to the second scoping notice, the BLM received six written comments. Public and agency comments have been grouped according to general subject area and are summarized in Table 1-1. Table 1-1 also provides references to the sections of this EIS that respond to each issue raised in the comments. Those scoping comments that do not apply or are beyond the scope of the Supplemental EIS are noted as such in the table.

Based on these comments and the BLM's internal review, five issues of concern were identified and are the focus of the Supplemental EIS:

- Potential impacts to surface and ground water resources, including the Humboldt River;
- Potential impacts to livestock operations;
- Potential impacts to threatened and endangered species;
- Potential impacts to riparian and wetland vegetation; and
- Potential impacts to wildlife and fisheries resources.

## Table 1-1
## Issues and Concerns Identified in Scoping

| Issue | SEIS Document Section(s) |
|---|---|
| **Surface Water** | |
| Describe effects on the water resources of the Maggie Creek/Boulder Creek basins and of the local vicinity, including the Humboldt River. | Chapter 3, Section 3.2.2. |
| Describe water disposal methods in detail, with volumes broken down according to disposal method. Disposal alternatives should be provided. | Chapter 1, Sections 1.4.3 and 1.5. |
| Modification of the flow volumes on the Humboldt River is a direct impact from the mining operations. Describe the affected environment and the known and anticipated environmental consequences, including cumulative impacts. | Chapter 3, Sections 3.2.1.3 and 3.2.2.2 (direct impacts), and Chapter 5, Section 5.2 (cumulative impacts). |
| Describe potential impacts on ground water and surface water, estimating rates of water produced and/or consumed by the proposed project as well as all other related projects. | Chapter 3, Sections 3.2.2.1 (direct impacts) and Chapter 5, Section 5.2 (cumulative impacts). |
| Discuss project compliance with state-adopted, EPA-approved water quality standards. | Chapter 3, Sections 3.2.2.1 and 3.2.2.2 for any predicted exceedences of approved water quality standards. |
| Discuss status of current NPDES permit(s) for discharges to surface water and whether any additional permits or modifications are anticipated in the future. | Chapter 3, Sections 3.2.1.3 and 3.2.2.2; discussed in *Cumulative Impact Analysis* of *Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Document project consistency with applicable storm water permitting requirements. | Not applicable to this SEIS because there would be no surface disturbance (other than pipeline route). |
| Describe drainage patterns in the project locale. Include hydrologic and topographic maps. | Chapter 3, Sections 3.2.1.1 and 3.2.1.3. |
| Identify whether any components of the operations fall within 50- or 100-year flood plains and discuss potential for flash floods to transport sediment from disturbed areas to stream channels. | Chapter 3, Sections 3.2.1.1 and 3.2.2.1. Also see Final Betze Project EIS |
| Discuss potential for contamination of surface flows and mitigation measures to prevent this contamination. | Chapter 3, Section 3.2.2.1 and 3.2.2.2. |
| Describe the quality of existing surface and ground waters. | Chapter 3, Section 3.2.1.2. |
| Discuss potential for and effects of movement of any contaminated surface water to the subsurface. | Chapter 3, Section 3.2.2 discusses potential water quality impacts associated with Barrick's dewatering and water management activities. No water quality impacts (or sources of contamination) are anticipated for the Proposed Action. |
| Describe the status of operations related to the existing TS Reservoir, its relationship to the 404 permitting process, and the connection between the TS Reservoir and water discharge impacts. | Chapter 1, Section 1.4.3, and Chapter 3, Section 3.2.2.1. |
| Examine pit filling after mining operations cease and resulting potential impacts to nearby surface water resources. | Chapter 3, Section 3.2.2.1. |
| Discuss any impacts (ground water discharge, etc) to the Humboldt River and any other surface water bodies (springs and tributary streams) resulting from the mining operation. | Chapter 3, Section 3.2.2.2. |

| Issue | SEIS Document Section(s) |
|---|---|
| Discuss effects of changing water supplies to downstream water users, both during discharge and following cessation of discharge, including potential impacts of water quality on water use such as crop production. | Chapter 3, Section 3.2.2.2; discussed in *Cumulative Impact Analysis* of *Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Estimate the additional evapotranspiration caused by raised water levels. | Chapter 3, Section 3.2.2.2. |
| Revise the previous pit lake study. | Chapter 3, Section 3.2.2.1. |
| **Groundwater** | |
| Consider additional recharge schemes upgradient from Boulder Valley to replenish the cone of depression. | Chapter 1, Section 1.5. |
| Consider recharge into faulted zones near the base of mountains. | Chapter 1, Section 1.5. |
| Provide detailed hydrologic data including pump tests of the lower Boulder Valley and a map of well levels. | Chapter 3, Section 3.2.2.1. |
| Use same wells used by USGS and update their ground water maps. | Ground water elevation maps were updated through 1998 in Section 3.2.1.2. |
| Consider enhanced natural recharge from the Humboldt River into the surrounding alluvium. | Potential impacts of mine dewatering discharges and water management operations on the Humboldt River are discussed in Section 3.2.2.2. |
| Quantify the pumping volume and provide an estimate of future pumping requirements. | Chapter 1, Section 1.4.3. |
| Summarize results of Barrick's groundwater flow model in a manner that is understood by the public. | Chapter 3, Section 3.2.2.1 and Appendix D. |
| Provide a technical summary of the groundwater model in an appendix. | Appendix D. |
| Compare Barrick's groundwater study with Newmont's. Validity and limitations of both models should be discussed. | Appendix D; discussed in *Cumulative Impact Analysis* of *Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Identify direct, indirect, and cumulative impacts to surface and groundwater flow, water supply wells, and springs and seeps as a result of groundwater pumping and mine water discharge associated with the project. | Chapter 3, Sections 3.2.2.1 (direct impacts) and Chapter 5, Section 5.2 (cumulative impacts). |
| Describe relationship between the pit and the hydrogeologic system. | Chapter 3, Section 3.2.1.2. |
| Document volumes of water taken from aquifer storage versus recharge rates, as a result of dewatering operations along the Carlin trend. | Estimates provided in the *Cumulative Impact Analysis* of *Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Delineate the area of the full cone of depression that may result from the pumping of groundwater. | Chapter 3, Sections 3.2.2.1 and 3.9. |
| Describe changes in the area of the cone of depression through time and potential impacts on springs, seeps, and streams. | Chapter 3, Section 3.2.2.1. |
| Describe groundwater mounding and spring development downgradient from TS Ranch Reservoir, including trace elements in the water. | Chapter 3, Section 3.2.2.1. |
| Discuss long-term ramification of losses of ground water and associated changes in evapotranspiration rates. | Chapter 3, Section 3.2.2.1 and Appendix D. |
| Discuss benefits of reinjecting water back into the carbonate aquifer upgradient of the mine, at latter stages of mining. | Chapter 1, Section 1.7. |
| Discuss potential effects of groundwater withdrawals on subsidence. | Chapter 3, Section 3.1.2. |

| Issue | SEIS Document Section(s) |
|---|---|
| **Vegetation/Grazing** | |
| Describe the extent and character of wetland development downgradient of TS Ranch Reservoir. | Chapter 3, Section 3.3. |
| Identify wetland and riparian habitat and other unique or important habitat areas that could be affected by the project. | Chapter 3, Section 3.3. |
| Discuss any impacts to grazing/livestock operations resulting from mine dewatering activities. | Chapter 3, Section 3.7 (direct impacts) and Chapter 5, Section 5.7.1 (cumulative impacts). |
| **Wildlife and Fisheries** | |
| Discuss effect of the conveyance system on wildlife movement across Boulder Valley. | Chapter 3, Section 3.4. |
| Discuss avoidance, minimization, and mitigation of losses or modifications of habitat and plant and animal species composition. | Chapter 3, Sections 3.4, 3.5, and 3.6. |
| Include a thorough section on direct, indirect, and cumulative impacts related to mine dewatering and discharge. Emphasis should be placed on the measured and anticipated effects to biologic resources, especially those of special status, within the area of influence caused by physical and chemical changes in the hydrologic system as a result of mining operations. | Chapter 3, Sections 3.4, 3.5, and 3.6 (direct impacts) and Chapter 5, Sections 5.4.1, 5.5.1, and 5.6.1 (cumulative impacts). |
| Identify areas with sensitive resources. | Chapter 3, Sections 3.4, 3.5, and 3.6. |
| Describe impacts to Lahontan cutthroat trout (LCT) from water quality degradation and contaminant mobilization from this and other projects potentially affecting the Maggie Creek and Rock Creek subbasins. | Chapter 3, Section 3.6 (direct impacts) and Chapter 5, Section 5.6.1 (cumulative impacts). |
| Describe potential impacts to wildlife dependent on wetlands downgradient from TS Ranch Reservoir | Chapter 3, Sections 3.5 and 3.6. |
| Describe effects of the project on LCT emigration and migration between creeks and implications to continued existence of each population. | Chapter 3, Section 3.6 (direct impacts); discussed in *Cumulative Impact Analysis* of *Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Describe potential to create potential introduction sites for nonnative aquatic species. Such introductions could result in LCT population declines through predation, competition, hybridization, or secondary introduction of parasites and diseases. | The Proposed Action and Barrick's anticipated water management operations would not create new sites with the potential to introduce non-native species to occupied or potential LCT habitat. As stipulated in the Decision Record for the Meikle Mine, Barrick has implemented measures to prevent the introduction of non-native species to open water management facilities. |
| Describe changes in the area of the cone of depression through time and potential impacts on springs, seeps, and streams, and associated biota. Include impacts to LCT, spring snails, and other endemic invertebrates, and riparian vegetation. | Chapter 3, Sections 3.2.2 and 3.6.2. |
| Discuss risks to wildlife, including migratory birds, from drinking pit lake water and/or consuming aquatic biota from the lake. | Chapter 3, Section 3.4. |
| Include potential impacts to instream and riparian habitats, distribution and size of downstream wetlands, and abundance and diversity of both aquatic and terrestrial species associated with the Humboldt River. | Chapter 3, Sections 3.3.2, 3.4.2, and 3.5.2. |
| Discuss bioaccumulation of trace elements and other constituents by aquatic biota in the pit lake. | Chapter 3, Section 3.4.2. |

| Issue | SEIS Document Section(s) |
|---|---|
| **Cumulative Impacts** | |
| Address potential cumulative impacts to resources in the context of past, current, and reasonably foreseeable future mining. Include discussion of impacts to water quality and quantity, air quality, soils, vegetation, wildlife, and biodiversity. | Chapter 5; discussed in *Cumulative Impact Analysis* of *Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Provide data on withdrawals and discharges from other operations within the Humboldt River basin. Emphasize water chemistry and potential effects to biologic resources. Reference the Humboldt River basin Assessment program and use existing monitoring data from that program. | Chapter 5, Sections 5.2, 5.3, 5.4, 5.5, and 5.6. |
| Determine potential impacts, including cumulative impacts, of the project on plant and wildlife species, especially species classified rare, threatened, or endangered on either state or Federal lists. Include candidate species. | Chapter 3, Sections 3.4, 3.5, and 3.6, Chapter 4, Sections 4.4, 4.5, and 4.6, and Chapter 5, Sections 5.3, 5.4, 5.5, and 5.6. |
| Discuss the series of future pit lakes within the Carlin Trend. | Chapter 3, Sections 3.2.2.1, 3.2.4.1, and 3.4.2.3; Chapter 5, Section 5.2.1. |
| Discuss cumulative effects of discharges of trace elements such as selenium, arsenic, and boron. | Chapter 5, Section 5.2; discussed in *Cumulative Impact Analysis* of *Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Discuss potential effects of project discharges on surface water quality, including cumulative impacts over time. | Chapter 5, Section 5.2 and discussed in *Cumulative Impact Analysis* of *Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Discuss impacts associated with mining effluent discharge to the Humboldt Sink, including the Humboldt Wildlife Management Area. | Chapter 3, Sections 3.2 and 3.4 and Chapter 5, Sections 5.2 and 5.4. |
| Describe impacts of the incremental and cumulative volume of discharge and seasonality of discharge on river hydraulics, hydrology, and stream bank stability. | Chapter 5, Section 5.2; discussed in *Cumulative Impact Analysis* of *Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Discuss potential overlapping cones of depression from all dewatering activities. | Chapter 3, Sections 3.2 and Chapter 5, Section 5.2; discussed in *Cumulative Impact Analysis* of *Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Discuss impacts of changes in water quality in the Humboldt River and related impacts to wetlands, including increased concentrations and loads of trace elements and other constituents, with associated impacts to aquatic species and migratory birds. Include potential impacts to aquatic birds, including effects on reproduction and survival, in Humboldt Wildlife Management Area. | Chapter 3, Sections 3.2, 3.4 and Chapter 5, Sections 5.2.2 and 5.2.4. |
| Address potential cumulative impacts to Traditional Cultural Properties in the Area of Potential Effect caused by dewatering. | Discussed in the *Cumulative Impact Analysis of Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Discuss potential cumulative impacts to sage grouse, a bird identified as significant to Western Shoshone culture. | Discussed in the *Cumulative Impact Analysis of Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |

| Issue | SEIS Document Section(s) |
|---|---|
| Discuss the ability to maintain traditional religious, healing, and educational practices in the assessment area. | Discussed in the *Cumulative Impact Analysis of Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Discuss impacts to natural elements that could impact Western Shoshone cosmology. | Discussed in the *Cumulative Impact Analysis of Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Address potential effects to surface waters in the Area of Potential Effect, including drying up of these waters or effects to water quality. | Discussed in the *Cumulative Impact Analysis of Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| **Mitigation/Monitoring** | |
| Consider using the Humboldt River to convey flow downstream to offstream recharge sites. | Chapter 1, Section 1.7. |
| Consider diverting a portion of the proposed discharge through the White House Ditch and Rock Creek system to benefit wildlife and wetland values. | Chapter 1, Section 1.7. |
| Consider planting and maintaining willows and other riparian vegetation on all disturbed areas on the Humboldt River. | Planting willows and other riparian vegetation along the Humboldt River would be impractical and unnecessary since Barrick does not control the private land and planting willows would not re-establish baseflows. |
| Fund an antelope winter range project in the hills north of the canal. | Chapter 3, Section 3.4.3 identifies mitigation measures for wildlife. |
| For the lined canal, consider reducing side slope angles and installation escape structures. Have a standard barbed wire fence and design the canal so animals can easily escape. | Chapter 1, Section 1.4. |
| Discuss how potential impacts from fill operations are currently being mitigated. Include: acreage and habitat type of waters of the US created, restored, or modified; water sources to maintain the mitigation area; revegetation plans; maintenance and monitoring plans; size of location and mitigation zones; parties ultimately responsible for plan's success; and contingency plans that would be enacted if the original plan fails. | Chapter 4, Section 4.3.1. |
| Discuss mitigation measures taken to prevent exposure of migratory waterfowl and other wildlife to any toxic waters. | Monitoring and mitigation (i.e., funding for research) was identified in the Betze EIS ROD (still applicable for the SEIS). |
| Include mitigation for replacement of habitat adversely affected by the project. | Chapter 1, Section 1.6. |
| Discuss mitigation/compensation measures including reclamation plans for the project site. | Chapter 3, Sections 3.4.3, 3.5.3, and 3.6.3. |
| Discuss the development of measures to avoid long-term impacts or limit them to insignificant levels. | Chapter 1, Section 1.6. |
| Describe how impacts will be monitored over the long-term to ensure significant impacts do not occur, including monitoring standards and parameters to be described. | Chapter 1, Section 1.6. |
| Discuss a mechanism for implementing additional mitigation/compensation measures in the event monitoring data indicate greater impacts than originally anticipated. | Chapter 1, Section 1.6. |

| Issue | SEIS Document Section(s) |
|---|---|
| **Miscellaneous** | |
| Encourage tiering to the original Betze EIS. | Chapter 1, Section 1.1. |
| Describe the primary purpose of the Supplemental EIS, which should not be confused with purpose and need of the proposed action. | Chapter 1, Sections 1.1. and 1.2. |
| Evaluate all reasonable alternatives, including reasonable alternatives not within the jurisdiction of the BLM. | Chapter 1, Section 1.5. |
| Discuss measures taken to analyze the environmental effects of the proposed action on minority communities and low-income populations. | Chapter 3, Section 3.8. |
| Describe measures taken to present opportunities for affected communities to provide input into the NEPA process. | Chapter 1, Section 1.3 and Chapter 5. |
| Describe consultations with potentially affected Tribes and the results of those consultations. | Chapter 3, Section 3.8; discussed in *Cumulative Impact Analysis* of *Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* on file at the BLM Elko Field Office. |
| Discuss potential effects of future land exchanges relating to mining. | Land exchanges are not proposed as part of this SEIS. |
| **Mine/Mill Facilities** | |
| Include Meikle operation within the scope of the EIS and fully describe and analyze in the document. | Brief summary of mine/mill facilities in Chapter 1, Section 1.4.2. No new or expanded facilities would occur as part of the water management operations. |
| Include substantial information and analysis of new mine-related activities or other information not included in the Betze EIS. | |
| Include a description of existing and anticipated Federal and state permits and regulatory requirements, and the responsible agencies. | |
| Describe designs of the existing ore processing facilities and any planned modifications and/or new facilities. | |
| Discuss how accidental releases of hazardous materials would be handled. Identify the potential impacts, methods for discovering such failures, and degree to which impacts would be reversible. | |
| Discuss acid generation/neutralization potential for waste rock, stockpiles, tailings, and backfill at the site, and appropriate mitigation measures. | |
| Describe applicable tests on ore and waste rock and the results for each test. | |
| Provide a Waste Rock Characterization and Disposal Plan. | |
| Project chemical characterization of water in any open ponds. | |
| If cyanide is to be used, describe the chemistry of cyanide in water and soil and estimate quantities of cyanide likely to be "lost" and its fate. | |
| Identify how solution impoundments would be treated to prevent poisonings. | |
| Consider covering any pregnant solution ponds. | |
| Assure maintenance would continue after operations or while operations are suspended. | |
| Discuss any measures to ensure compliance with Resource Conservation and Recovery Act regulations. | |

| Issue | SEIS Document Section(s) |
|---|---|
| Describe measures taken to decommission mine operations, and neutralize or cap waste rock, tailings, and leach heaps. | |
| Identify areas targeted for reclamation, and clarify the intended degree of treatment in each area, including irrigation requirements. | |
| Discuss timing of reclamation relative to mining operations and duration of reclamation treatment. | |
| Provide standards for determining and means of assuring successful reclamation. | |
| **Air Quality** | |
| Discuss NAAQS and PSD increments applicable to air quality in the project area. | Not applicable to this SEIS because no new air emissions would occur as a result of water management operations. |
| Identify any Class I PSD areas within 100 kilometers of the project site. | |
| Discuss New Source Performance Standards for Metallic Mineral Processing Plants with respect to the proposed project. | |
| Explain how the proposed project is in conformity with the Nevada State Implementation Plan (SIP). | |
| Discuss the possibility of an air quality monitoring program to ensure project compliance with all applicable air quality standards and permits. | |

## 1.4 Description of Barrick's Continuing Operations

### 1.4.1 Location and Land Ownership

Barrick's existing gold mining operations are located on the western flank of the Tuscarora Mountains in north-central Nevada, approximately 23 miles northwest of Carlin, Nevada, as depicted in Figure 1-1. The Goldstrike property is situated in the Little Boulder Basin, a topographic feature that contains the drainages of Rodeo Creek, Brush Creek, Bell Creek, and Boulder Creek (see Section 3.2.1.3, Surface Water). Brush and Bell Creeks drain to Rodeo Creek, and Rodeo Creek converges with Boulder Creek in northern Boulder Valley, west of the active mining area. Elevations in Little Boulder Basin range from 5,100 feet above mean sea level (amsl)[1] in the foothills of Boulder Valley to over 8,700 feet amsl (USGS) at the peak of the Tuscarora Mountains, a north-trending range typical of the Basin and Range physiographic province.

Boulder Valley extends from Little Boulder Basin southwest approximately 20 miles to the Humboldt River. Elevations in lower Boulder Valley range from 4,590 feet amsl (USGS) at the valley floor to over 8,000 feet amsl (USGS) at the peaks of the Tuscarora Mountains. Boulder Valley is bounded on the east by the Tuscarora Mountains and on the west by the Sheep Creek Mountains. Boulder Creek and Rock Creek are the prominent drainages in Boulder Valley; both creek channels become extensively braided in lower Boulder Valley, and flows are ephemeral, rarely reaching the Humboldt River.

Barrick owns or controls approximately 8,000 acres of land within Little Boulder Basin and Boulder Valley. In addition, by virtue of agreements with Newmont and its subsidiary ELLCO, Barrick has rights to make use of certain lands owned by Newmont and ELLCO in Boulder Valley. The land status in Little Boulder basin and Boulder Valley is depicted in Figure 1-2.

At the time the Betze Plan was submitted to the BLM and the Betze Final EIS was prepared, most of Barrick's mining operations were being conducted or planned to be conducted on public lands managed by the BLM. In 1994, Barrick received patents under the General Mining Law to 1,793 acres of land on which the Betze-Post Mine, the Meikle Mine, and most of Barrick's milling and beneficiation operations are situated. Subsequently in 1995, Barrick completed a land exchange with the BLM that transferred 1,657 additional acres of public land at the Goldstrike property to Barrick (BLM 1994a). The North Block Tailings Facility and most of the waste rock disposal area are situated on the land acquired in the 1995 land exchange. A second land exchange was completed in 1997 that transferred 1,279 acres of public land to Barrick (BLM 1995). At present, all of Barrick's mining operations are being conducted on private land owned by Barrick or Newmont with the exception of approximately 300 acres of a waste rock disposal area, ore stockpiles, topsoil stockpiles, and a laydown area that are located on public lands. Similarly, all of Barrick's milling and beneficiation operations are being conducted on private land owned by Barrick or Newmont, except for the approximately 95 acres of the North Block Tailings Facility embankment that are situated on public land. Table 1-2 provides a list of the permits currently in place at the Goldstrike property and the responsible regulatory agencies.

### 1.4.2 Mining, Milling, and Beneficiation Operations

Barrick presently is mining the Betze-Post Mine, an open-pit mining operation, and the Meikle Mine, an underground mining operation. The Betze-Post Mine operation produces ore from property owned by Barrick and from property owned by Newmont. Under the terms of an agreement with Newmont, Barrick mines ore from Newmont property and delivers it to Newmont for gold recovery. The ore produced from Barrick's

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[1] Unless otherwise indicated, references to elevation bases are established by Barrick. There are differences among the three survey systems currently in use in the area (Barrick, Newmont Gold Company, and U.S. Geological Survey [USGS]); for consistency, this document is based on Barrick's survey and elevations.

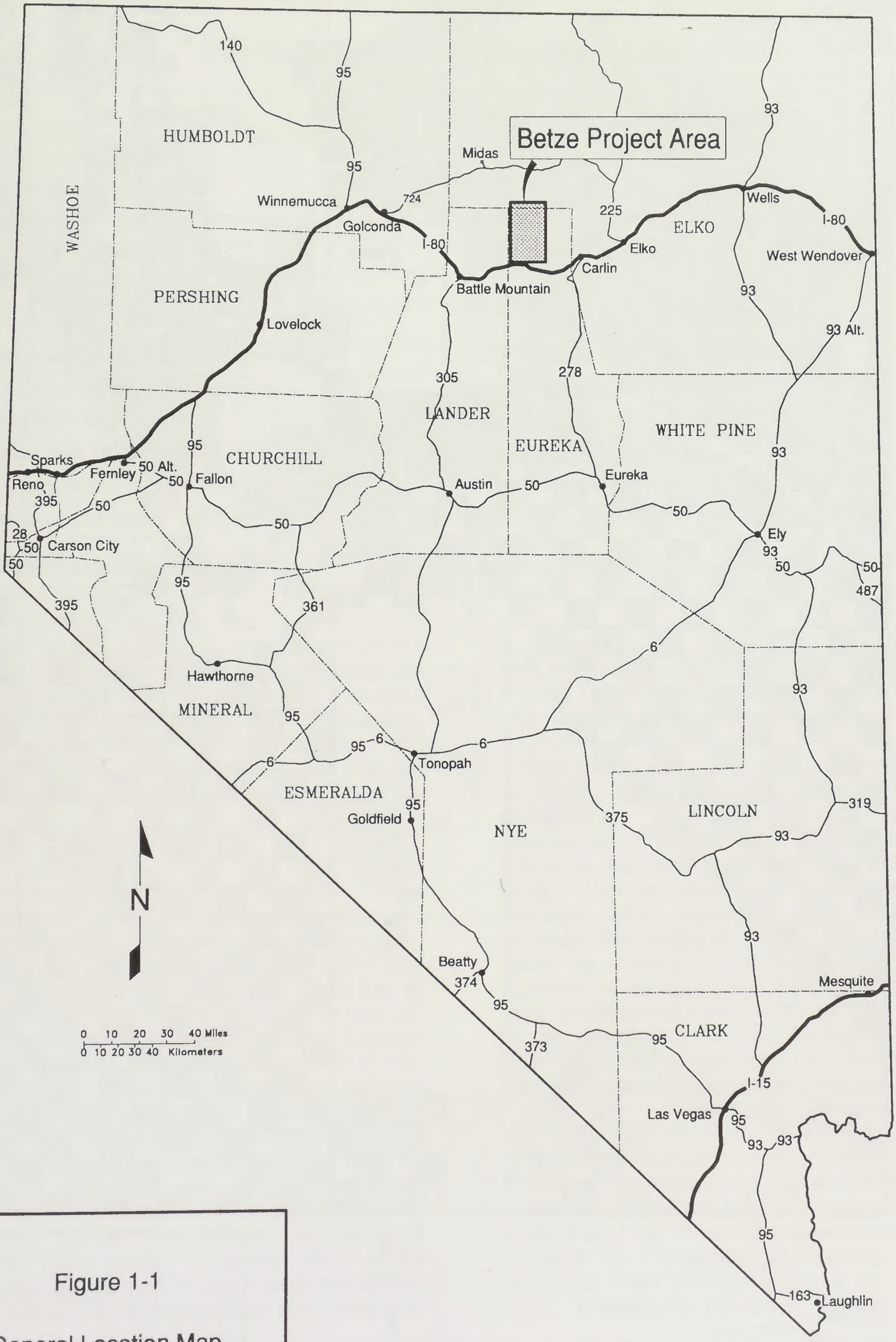

Figure 1-1

General Location Map

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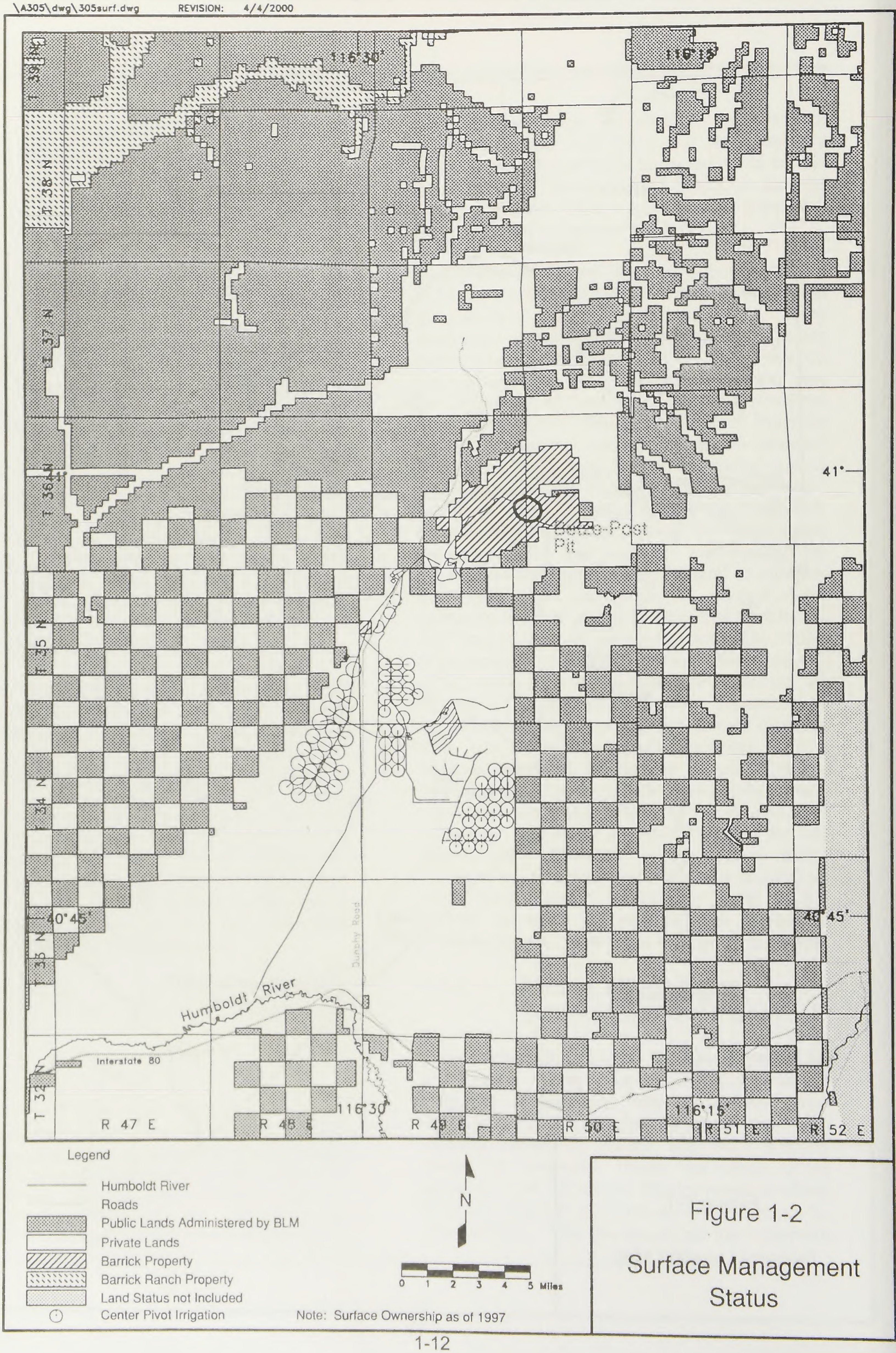

Figure 1-2

Surface Management Status

Table 1-2
Permits Currently Authorized at the Goldstrike Mine

| Permits | Regulatory Agency |
|---|---|
| Water Pollution Control Permits (Mining Facilities Permit, Infiltration Permits) | NDEP, Bureau of Mining Regulation and Reclamation |
| Sewage System Approvals | NDEP, Bureau of Water Pollution Control |
| Underground Injection Permits | NDEP, Bureau of Water Pollution Control |
| Stormwater Permits | NDEP, Bureau of Water Pollution Control |
| NPDES Permit | NDEP, Bureau of Water Pollution Control |
| Potable Water Permits | NDEP, Bureau of Water Pollution Control |
| Individual Sewage Disposal Systems | NDEP, Bureau of Water Pollution Control |
| Air Quality Operating Permits | NDEP, Bureau of Air Quality |
| Open Burn Permit | NDEP, Bureau of Air Quality |
| Radioactive Materials License | Nevada Division of Health |
| Industrial Artificial Pond Permits | Nevada Division of Wildlife |
| Reclamation Permits | Nevada Bureau of Mining Regulation and Reclamation |
| Nationwide Permits (Section 404) | U.S. Army Corps of Engineers (USCOE) |

portion of the Betze-Post Mine and from the Meikle Mine is delivered to Barrick's milling and beneficiation facilities for gold recovery. Barrick's mining, milling, and beneficiation (i.e., roaster, pads, heap leach, tailings facilities, etc.) operations are shown in Figure 1-3 and are described in the following sections.

#### 1.4.2.1 Betze-Post Mine

The Betze-Post mining operation uses conventional drilling, blasting, excavating, and hauling methods to remove overburden and gold-bearing ore. Drill rigs are used to drill blast holes that are charged with ammonium nitrate fuel oil (ANFO) prill (or slurry) and blasted. The resultant broken rock is excavated on production benches that have individual heights of either 20 or 40 feet. Excavation is performed by electric and hydraulic shovels and large front-end loaders. Currently, haul trucks with carrying capacities of 190 to 300 tons are used to transport material from the mine to the waste rock disposal areas, to Newmont, or to Barrick's milling and beneficiation facilities. Barrick has installed an overhead electric trolley system on several ramps in the mine and established haulage routes that enable the haulage trucks to operate on line power over the longer, steeper grades. The trolley system increases the speed of the trucks, reduces the amount of diesel fuel consumed by the trucks, and increases the life of the truck engines.

Barrick presently is mining the Betze-Post Pit at an average rate of approximately 420,000 tons of material per day. The existing surface disturbance of the open pit is approximately 970 acres, the mine is approximately 1,200 feet deep, 6,000 feet wide, and 9,000 feet long. Barrick's initial agreement with Newmont projected that mining of the Betze and Post pit would be completed by the end of 2005. Newmont is developing the Deep Post Deposit using underground mining methods. The portals for the underground mine are situated on private land within the Betze-Post Pit. Barrick and Newmont adopted an agreement that coordinates the operation of Barrick's open-pit mining operations with Newmont's underground mining operations. In addition, based on 1999 changes in mineral ownership, the parties revised the existing agreement that they have been operating under since 1992. These changes are expected to result in completion of open-pit mining operations under that agreement at the end of 2001, several years earlier than

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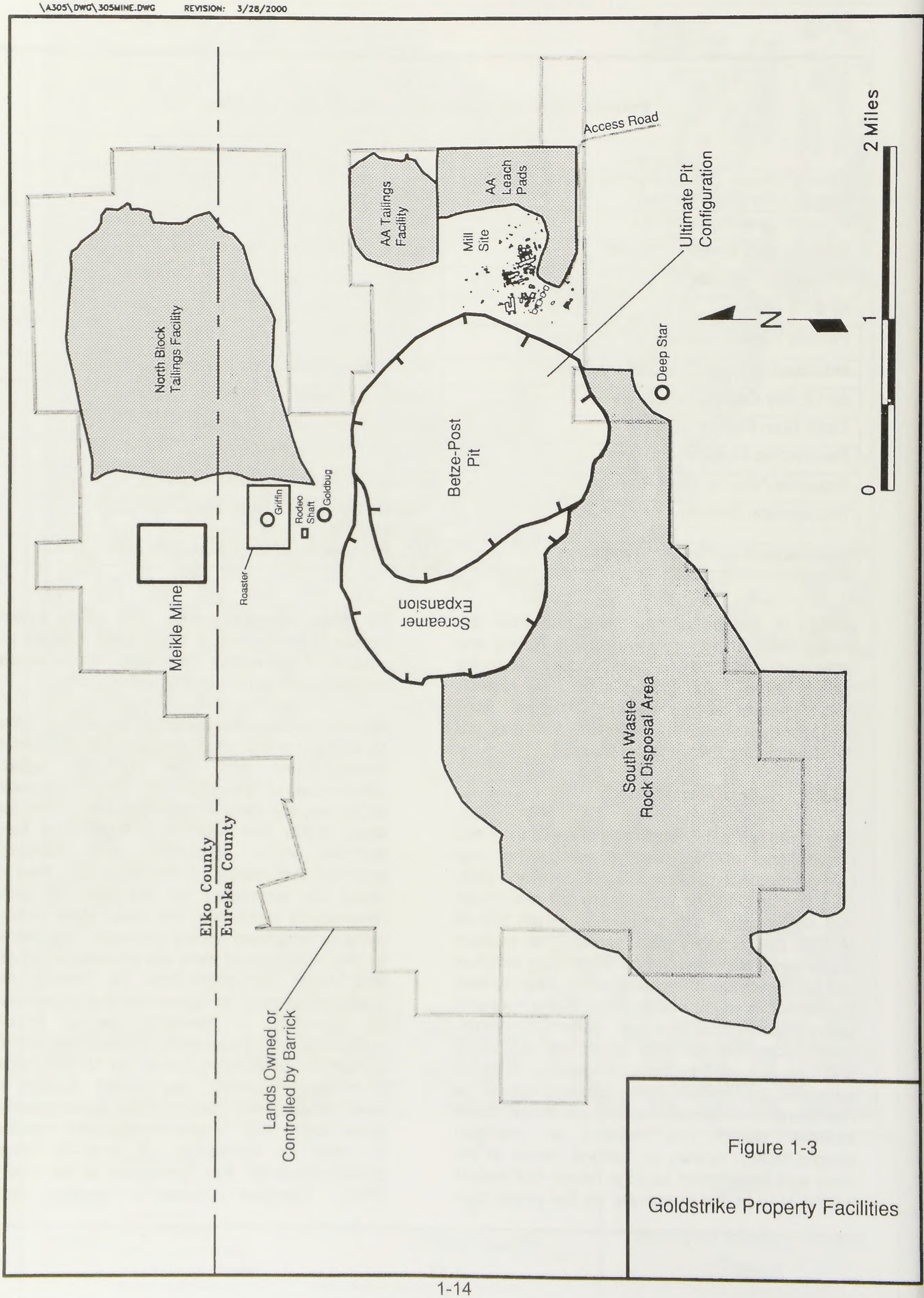

Figure 1-3

Goldstrike Property Facilities

initially planned. In addition to the Betze and Post deposits, Barrick has discovered or delineated other deposits, including the West Betze and Screamer deposits, that Barrick intends to mine through further development of the Betze-Post Mine by open-pit or potential underground mining methods. Barrick's present mine plan projects that mining will continue at the Betze-Post Mine through the year 2011. Ore and waste volumes to be mined during the next 5 years are shown in Table 1-3. A projected final pit configuration, which would disturb approximately 1,380 acres, is presented in Figure 1-3. This configuration extends into a larger area than the pit area analyzed in the Betze EIS. The mine plan through the year 2011 has been used to develop the ground water pumping and ground water recovery projections for purposes of this Supplemental EIS.

#### 1.4.2.2 Meikle Mine

The Meikle Mine is an underground mine that Barrick began to develop in 1994 to mine the Meikle deposit. The location of the Meikle Mine is shown in Figure 1-3. Barrick initiated production from the upper levels of the Meikle deposit in late 1996. During 1999, Barrick deepened the production shaft to a depth of 1,800 feet to provide access to the lower levels of the Meikle deposit. The ventilation shaft has been completed to a depth of 1,320 feet. During the first half of 1999, the Meikle Mine produced an average of 2,392 tons of ore per day. With completion of the underground workings at lower elevations, production is expected to increase to 3,800 tons per day during the second half of 1999. Production from the Meikle Mine is scheduled to continue through the year 2010. A more complete description of the Meikle Mine is provided in the Meikle Mine Development Environmental Assessment (BLM 1993a). Ore from the Meikle Mine is delivered to Barrick's milling and beneficiation facilities for gold recovery.

#### 1.4.2.3 Rodeo and Goldbug Exploration

Barrick developed an exploration shaft at the Rodeo deposit, just south of the Meikle Mine, in 1998. The location of the Rodeo exploration shaft is shown in Figure 1-3. The exploration shaft provides Barrick with underground access to explore the Griffin deposit, located between the Rodeo shaft and the Meikle Mine, and the Rodeo deposit. As part of an asset exchange with Newmont that was completed in May 1999, Barrick acquired the Goldbug deposit, located south of the Rodeo shaft as shown in Figure 1-3. Barrick initiated underground drift development from the Rodeo shaft to the Goldbug deposit in mid-1999. Exploration of the Rodeo, Griffin, and Goldbug deposits will continue in an effort to develop additional ore reserves.

#### 1.4.2.4 Heap Leach Facilities

The North Block Heap Leach Facility, which was located on the North Block, has been decommissioned, the spent leach material removed to the North Block Tailings Impoundment, and the facilities removed to facilitate development of the North Block Tailings Impoundment embankment and ore stockpiles in the area. The majority of the ore placed on the heap leach pads was near-surface oxide gold ore mined from the Post and Betze-Post mines. In 1998, Barrick produced approximately 19,700 ounces of gold from its heap leaching operations. A more complete description of Barrick's heap leach operations is provided in Section 2.1.4.1 of the Betze Draft EIS.

#### 1.4.2.5 Milling and Beneficiation Facilities

Barrick has constructed milling and beneficiation facilities on Barrick's private land as depicted in Figure 1-3. The milling facilities include two separate mill circuits that are presently capable of handling approximately 20,000 tons of ore per day. After the ore passes through the grinding circuit, it is delivered to one of six pressure oxidation vessels (autoclaves) in which heat, pressure, and oxygen are added to the ore slurry to oxidize the sulfide minerals in the ore. Following the pressure oxidation circuit, the ore slurry is delivered to the carbon-in-leach vessels where a dilute cyanide solution is used to dissolve the gold in the ore. The gold is then adsorbed onto activated carbon particles that are screened from the slurry and sent to the stripping circuit for gold recovery. The ore slurry, now referred to as tailings, is treated with Caro's acid or the INCO process to neutralize residual cyanide, and the slurry is pumped to one of Barrick's two tailings disposal facilities, the North Block Tailings Facility and the AA Tailings

Table 1-3
Goldstrike Property Mining Plans Through the Year 2004
(in millions of tons)

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|
| **Betze-Post Pit** | | | | | | |
| Total Ore Mined | 5.2 | 10.0 | 15.1 | 12.6 | 6.0 | 11.6 |
| Total Waste Mined | 153.9 | 134.9 | 134.8 | 138.0 | 143.9 | 138.9 |
| Total Mined | 159.2 | 145.0 | 150.0 | 150.6 | 149.9 | 150.5 |
| **Meikle Underground Mine** | | | | | | |
| Total Ore Mined | 1.0 | 1.1 | 1.5 | 1.5 | 1.8 | 1.9 |
| **Goldstrike Processing** | | | | | | |
| Total Mill Throughput | 5.9 | 9.4 | 10.4 | 10.4 | 10.4 | 10.4 |
| Total to Leach Pad | 0 | 0 | 0 | 0 | 0 | 0 |

Facility. The tailings solids settle in the impoundment, and the fluids are recycled to the mill for continued use.

During 1998, Barrick initiated construction of a dry grinding and roasting plant (roaster facility) on private land owned by Barrick just south of the Meikle Mine. The roaster facility has a nominal capacity of 18,500 tons of ore per day. The facility is composed of the following primary components: ore crushing facilities, dry ore grinding circuits, ore oxidation (roasting), carbon-in-leach gold recovery process, and ancillary processes. The roaster facility enables Barrick to oxidize carbonaceous ore so that gold can be recovered efficiently by the carbon-in-leach process. The Nevada Division of Environmental Protection, Bureau of Air Quality issued an air quality permit for the roaster facility that includes emissions control and monitoring requirements. Barrick anticipates that construction of the roaster facility will be completed and production will begin during 2000.

During 1998, Barrick produced approximately 2,326,000 ounces of gold from its milling operations. Barrick presently anticipates that almost all of the gold from the ore produced from its surface and underground mining operations in the future will be recovered through the mill facilities. A more complete description of the milling and beneficiation processes is presented in Sections 2.1.4.2 and 2.2.3.2 of the Betze Draft EIS.

### 1.4.3 Water Management Operations

The gold deposits that Barrick is presently mining and plans to mine in the future are situated below the pre-dewatering water table. In order to mine the Betze deposit, Barrick initiated a ground water pumping program in February 1990. As authorized by water appropriations issued by the Nevada State Engineer's Office, Barrick has pumped up to approximately 70,000 gpm. At the time the Betze EIS was prepared, Barrick projected that ground water pumping operations would lower the water level by 1,160 feet over a 10-year period. The ground water model used in the Betze EIS projected pumping rates based on that schedule and estimated that a total of approximately 285,000 acre-feet of water would be pumped to achieve the water level objective. From 1990 to the first quarter of 1996, Barrick lowered water elevations by about 1,300 feet and pumped approximately 446,000 acre-feet of water. In effect, Barrick lowered water elevations more than projected in 1990 and in half the time.

As a result, the pumping rates exceeded the projections presented in the Betze EIS.

At the end of 1998, water levels were at about the 3,738-foot elevation (1,527 feet below the original elevation); about 621,000 acre-feet of water had been pumped. In April 1996, Barrick reduced pumping rates to match water demand for mining, milling, and irrigation uses for a period of approximately 12 months. During that period, water levels rose approximately 225 feet due to Barrick's curtailment of ground water pumping operations. In the second half of 1997, water levels declined after Barrick increased pumping rates to a maximum of approximately 65,000 gpm (average quarterly rate). Pumping rates were maintained above 60,000 gpm through the first quarter of 1999. From the second quarter of 1999 through the end of 2009, pumping rates were projected to be reduced gradually from approximately 50,000 in the second quarter of 1999 to 15,000 gpm at the end of 2009 (Barrick 1999b). In approximately 2010, dewatering would cease; however, approximately 2,000 to 4,000 gpm of ground water would be pumped for up to an additional 10 years for mine reclamation and mineral processing activities.

As described above and in Section 1.1, Barrick's continued dewatering and discharge activities are conducted in compliance with its approved water appropriations and NPDES Permit. Following the identification of increased pumping rates and ground water drawdown beyond the estimates projected in the Betze Project EIS, the BLM and Barrick agreed to conduct supplemental analyses of Barrick's ground water pumping and water management operations. This Supplemental EIS and the associated CIA (BLM 2000b) address these issues. Consistent with conditions of the state water appropriations and the Betze Record of Decision, Barrick has established and regularly monitors an extensive network of surface and ground water monitoring sites. The results of the monitoring program are reported quarterly to the State Engineer and the BLM in the Boulder Valley Monitoring Plan (BVMP). The following section describes the facilities developed to pump the ground water and to use, store, or manage the ground water produced by Barrick's pumping operations.

#### 1.4.3.1 Wells and Collection System

Barrick produces ground water from in-pit wells and sumps, horizontal drains, and perimeter wells. Initially the majority of the water was pumped from in-pit wells and sumps; however, Barrick has now established a well field outside the boundaries of the present mine that is capable of pumping most of the water to achieve Barrick's ground water drawdown objectives. Based on the experience gained during the past 9 years of ground water pumping operations, Barrick has defined four zones from which ground water is produced (see Section 3.2.1.2 Ground Water). The first area, which is bounded by the Post and Siphon faults, is very transmissive and produces the majority of the water. The second area, to the east of the Post Fault, is less transmissive and produces a relatively small percentage of the water. The third area, to the south of the Granodiorite stock, is highly transmissive yet produces only a small percentage of the water as the low transmissive nature of the stock limits flow from this area. Fourth, to the northwest of the mining areas, the rocks are also less transmissive and produce only a small percentage of the water pumped. Barrick has drilled a total of 34 wells in the highly transmissive area. These wells typically are up to 2,000 feet deep, are fitted with 2,000 -horsepower downhole pumps, and are capable of producing up to 2,500 to 3,000 gpm. In contrast, the over 100 wells drilled by Barrick in the less transmissive area typically are 1,000 feet deep, are fitted with 10 to 350-horsepower downhole pumps and are capable of producing only 25 to 300 gpm. In addition, Barrick has installed approximately 500,000 feet of horizontal drains in the walls of the mine which initially produce anywhere from 0 to 200 gpm. Water production from individual horizontal drains drops rapidly with time, usually stopping within a 4-week period. In the future, Barrick may drill additional wells on private land to replace the existing wells that are situated within the ultimate pit shell depicted in Figure 1-3.

Water is pumped from the production wells through a network of high density polyethylene (HDPE) and steel pipes either to process water tanks or to a 72-inch diameter gravity-flow pipeline. Approximately 4,000 to 8,000 gpm of water are delivered to Barrick for mining and milling uses, to Barrick's Meikle Mine, or to Newmont for mining and milling use. Mining and milling uses of water include process make-up water for mill ore slurry or heap leach solution, road dust control watering, exploration drilling, and sanitary uses.

Water that is not used for mining or milling purposes is delivered to the gravity flow pipeline. Barrick is authorized by a discharge permit issued by the NDEP, Permit NEV89068, to discharge water produced by its ground water pumping operations to ground waters of the state via percolation, infiltration, and irrigation. Initially, all water was delivered to the West No. 9 Pit where a portion of the water was treated to remove naturally occurring arsenic using a ferric sulfate process. The water was discharged from the West No. 9 pit to an unnamed drainage to the TS Ranch Reservoir. A gravity flow pipeline (Figure 1-4) was installed in 1993, and discharges to the unnamed drainage were discontinued permanently in 1997 when Barrick extended the existing waste rock disposal area across the upper reach of the unnamed drainage. Barrick anticipates that the present practice of delivering water from the well field to the TS Ranch Reservoir area through the gravity flow pipeline will continue throughout the remaining life of the mine. If necessary to ensure compliance with arsenic water quality limits in Barrick's discharge permit, Barrick will relocate the arsenic treatment plant to the vicinity of the gravity flow pipeline. A more complete description of Barrick's water collection system is provided in Section 2.2.2.6 of the Betze Draft EIS.

#### 1.4.3.2 TS Ranch Reservoir

Construction of a reservoir at the lower end of the unnamed drainage, referred to as the TS Ranch Reservoir (Figure 1-4), began in 1989. Initially, the impoundment structure was to be built in four stages to provide an ultimate storage capacity of 20,000 acre-feet of water. Stage II of the impoundment structure was completed and the State Engineer authorized Barrick to begin impounding water in the TS Ranch Reservoir in March 1990. Construction of the impoundment continued to Stage III. Stage IV of the impoundment structure, including installation of the permanent spillway, was not completed due to the appearance of a naturally occurring permeable fracture in the reservoir floor. The State Engineer approved operation of the TS Ranch Reservoir as built to the Stage III level.

Barrick began delivering water to the TS Ranch Reservoir via the unnamed drainage in May 1990. Monitoring of discharge quantities and reservoir levels indicated that the reservoir was not filling as initially anticipated due to the appearance of the fracture. The State Engineer's Office requested information from Barrick on the fracture and water levels in the area. Barrick responded to the State Engineer's request and has incorporated updates of the hydrographs requested by the State Engineer in the BVMP.

Barrick continued to deliver water to the TS Ranch Reservoir, and the majority of the water infiltrated into the rhyolite formation underlying the reservoir until April 15, 1996, when in compliance with a temporary restraining order, Barrick limited pumping to no more than 8,000 gpm. From April 1996 until April 1997, Barrick pumped an average of 5,680 gpm. All of the water produced during this period was used for mining and milling purposes by Barrick and Newmont. During this period, water levels in the highly transmissive carbonate rocks in the area of the mines rose by 225 feet, and water levels in the area of the TS Ranch Reservoir declined by 58 feet. Based on an agreement between Barrick and Newmont, the temporary restraining order was dissolved, and Barrick constructed facilities to treat and discharge water produced by its ground water pumping operations to the Humboldt River in compliance with Barrick's NPDES Permit.

The construction projects included installation of an impermeable liner along the cooling channel and the coffer dam area of the TS Ranch Reservoir to preclude infiltration of ground water from pumping operations into the rhyolite formation. Subsequent agreements between Barrick and Newmont have relieved Barrick of the obligation to maintain the liner along the cooling channel and, subject to certain conditions, under the coffer dam area. Descriptions of the water treatment and discharge facilities and Barrick's water management program are provided in the following sections.

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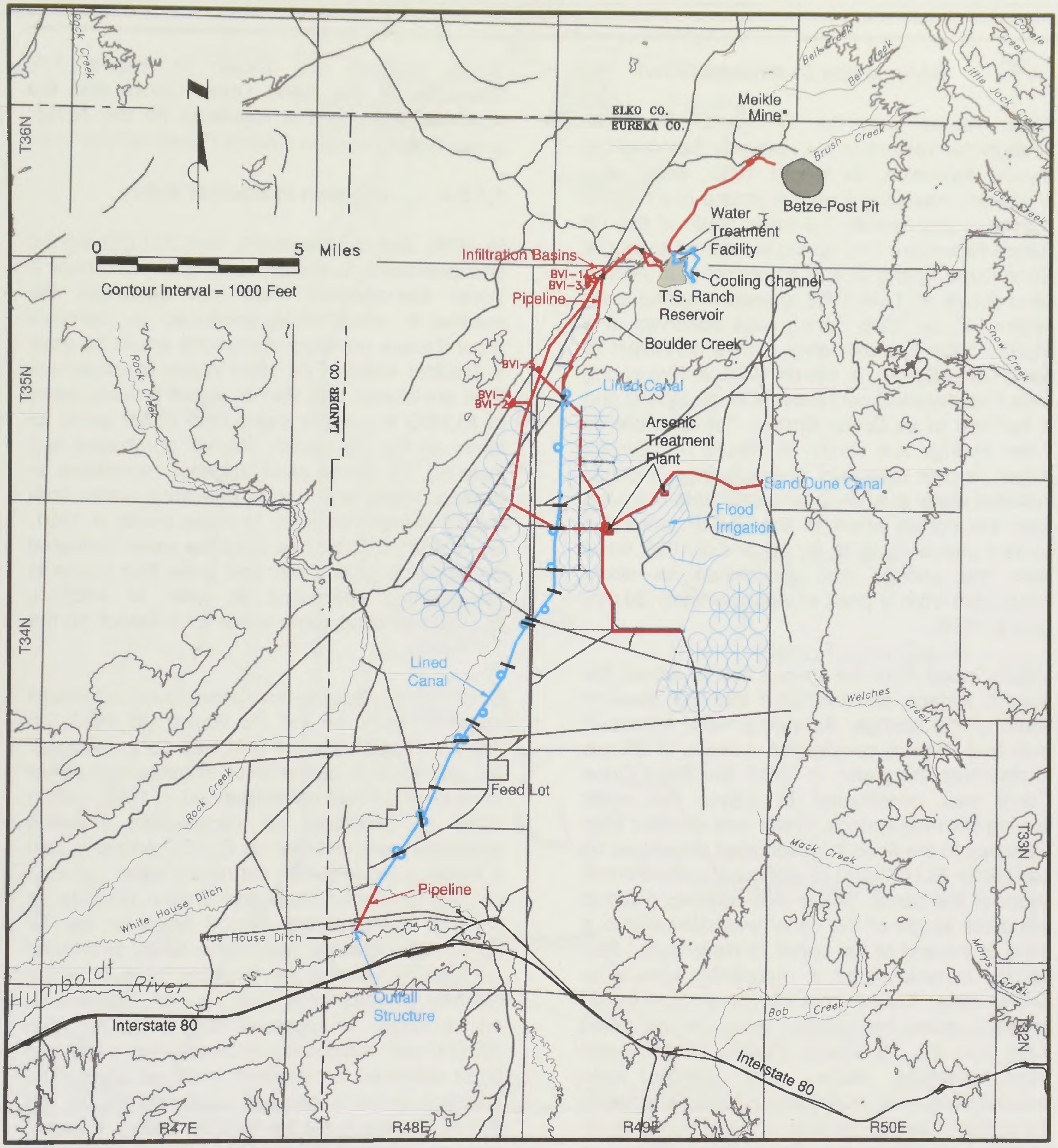

Legend

| | |
|---|---|
| — - — | County |
| —— | Township |
| —— | Road |
| —— | River, Creek, or Ditch |
| —— | Pipeline |
| —— | Conveyance Canal |
| BVI-3 ◆ | Injection Wells |
| ○ | Center Pivot Irrigation |
| ▬ | Crossing |
| ● | Watering Pond |

Figure 1-4

Water Operations Components

#### 1.4.3.3 Springs and Sand Dune Canal

Water flowed from the TS Ranch Reservoir through the fracture in the reservoir floor into the rhyolite formation. In March 1992, water was observed emanating from the ground at a rhyolite outcrop approximately 5.5 miles south of the TS Ranch Reservoir. This spring is referred to as the Sand Dune Spring due to its proximity to nearby sand dunes. In June 1992, a second spring area, referred to as Knob Spring, was observed at a rhyolite knob approximately a mile northwest of Sand Dune Spring. In March 1993, a third spring area was detected northwest of Knob Spring and is referred to as Green Spring. The locations of these springs are shown in Figure 1-5. Barrick began regular sampling of the springs and has included water quantity and quality data collected from the spring areas in the BVMP since the second quarter of 1992. By the end of 1998, flows from the springs had diminished to about 5,000 gpm from a peak of approximately 30,000 gpm in 1996.

Initially, water from the springs flowed across the ground surface and infiltrated into the alluvium south of the springs. As spring flows increased over time, Barrick constructed a series of ditches to distribute the water. In 1993, the Sand Dune Canal was constructed to collect the water flowing from the springs. Water was diverted from the canal to the flood irrigation area developed by Barrick for ELLCO and to additional upland areas south of the canal. Water that was not diverted along the length of the canal was delivered to a pond at the end of the canal. In November 1994, Barrick commissioned a pumpback system to deliver water flowing from the canal pond to the irrigation areas, the injection wells, the infiltration area, and the TS Ranch Reservoir. A second pond, pumping station, and pipeline were installed by Barrick in the fall of 1995. At present, the system has the capacity to pump in excess of 45,000 gpm from the Sand Dune Canal to irrigation, infiltration, or injection. In 1995, Barrick also installed and commissioned an arsenic treatment plant at the end of the Sand Dune Canal to remove naturally occurring arsenic from the canal flows prior to infiltration or injection. These facilities are shown in Figure 1-5. Operation of the Sand Dune Canal and the recirculation system is regulated by the NDEP under Water Pollution Control Permit NEV95114.

#### 1.4.3.4 Irrigation in Boulder Valley

In 1990, Barrick, Newmont, and ELLCO signed and presented to the Nevada State Engineer a Water Management Plan that described the manner in which water produced by Barrick's ground water pumping operations would be used in Boulder Valley. The 1990 Water Management Plan envisioned that Barrick would provide water to ELLCO to irrigate more than 5,000 acres of lands on the TS Ranch. Barrick purchased and installed 15 center-pivot irrigation sprinklers in Boulder Valley and began delivering water from the TS Ranch Reservoir to these pivots in 1991. Since then, ELLCO has used the water delivered by Barrick to grow alfalfa and grass that it uses in its ranching operations or sells. In addition, ELLCO has used some water for livestock on the TS Ranch.

Since 1991, Barrick has developed additional irrigation areas on the TS Ranch. In 1993, an 830-acre flood irrigation field was commissioned. An additional 8 center-pivot irrigation sprinklers were installed and commissioned in 1995, and in 1996 an additional 48 center-pivot irrigation sprinklers were installed on ELLCO property, and 2 center-pivot irrigation sprinklers were installed on land owned by Dean and Sharon Rhoads. At present, approximately 10,000 acres on the TS Ranch and Rhoads' land have been developed for irrigation. During the irrigation season, which typically extends from April through September, an average of approximately 46,000 gpm (60,000 gpm maximum) of dewatering water has been delivered for irrigation of these lands. The irrigation systems can be supplied from the TS Ranch Reservoir via the Boulder Valley irrigation pipeline or from the Sand Dune Canal. During the irrigation season, water from the Sand Dune Canal is delivered to and consumed at the irrigation areas. If irrigation demand exceeds flow from the Sand Dune Canal, additional water can be delivered from the TS Ranch Reservoir to the irrigation areas. The locations of the irrigation facilities are depicted in Figures 1-4 and 1-5.

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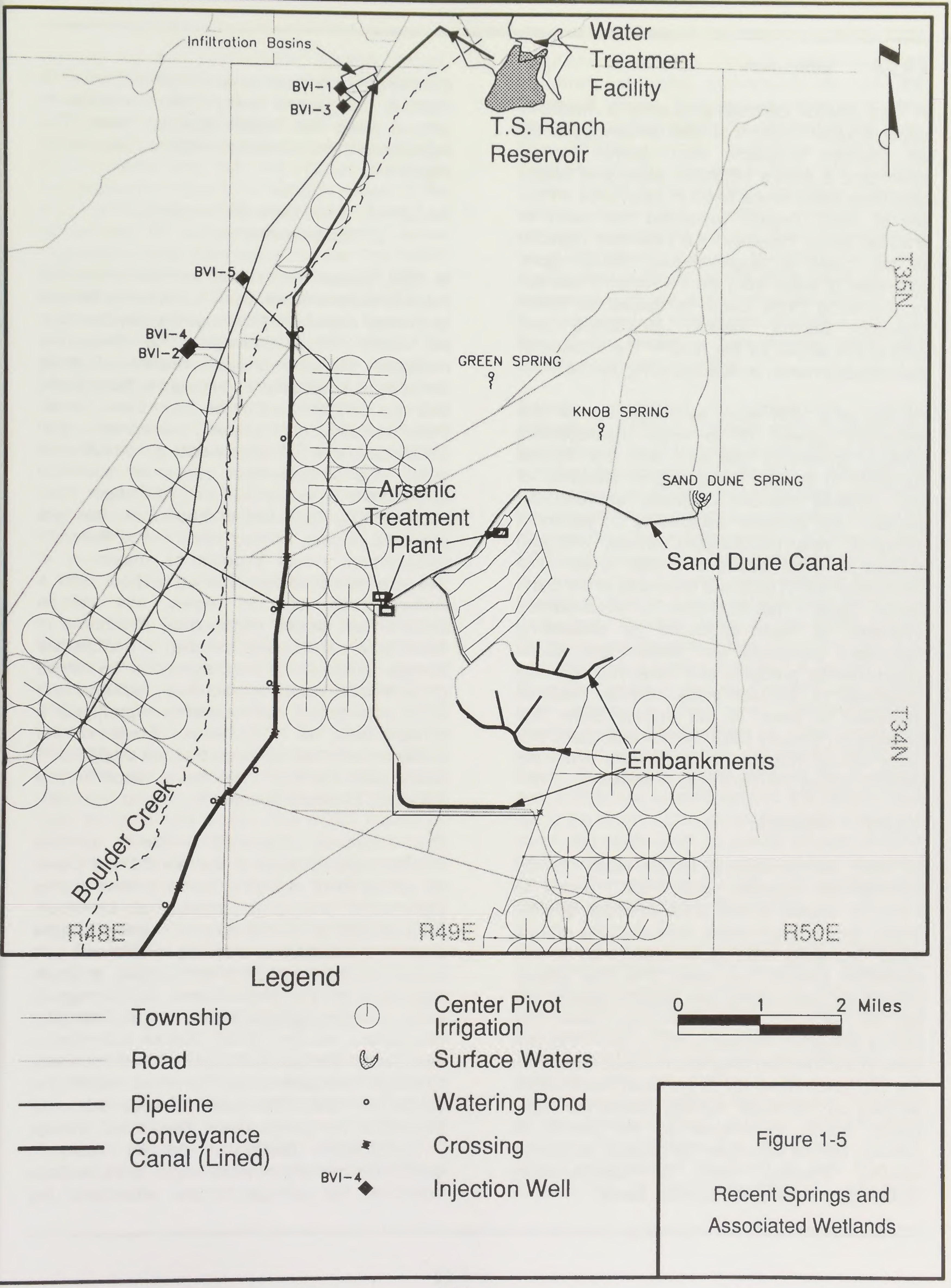

Figure 1-5

Recent Springs and Associated Wetlands

### 1.4.3.5 Infiltration

In 1993, Barrick identified an outcrop of rhyolite in upper Boulder Valley that was determined to be an effective infiltration area. Barrick initially developed a 4-acre infiltration basin and began delivering water to the basin in April 1994. In the fall of 1995, Barrick expanded the basin to 6 acres, which increased the infiltration capacity of the basin to approximately 15,000 gpm. Infiltration of water from the TS Ranch Reservoir or the Sand Dune Canal is subject to Water Pollution Control Permits NEV89068 and NEV95114 issued by the NDEP. The location of the infiltration basin is depicted in Figure 1-4.

As part of a 1999 asset exchange, Barrick and Newmont agreed on a water management protocol governing infiltration into the rhyolite formation in Boulder Valley and an allocation of the available infiltration capacity between the parties. The protocol establishes a maximum infiltration rate (20,000 gpm annual average) subject to limits based on water levels in a monitoring well (TS-2) and flow rates in the Sand Dune Canal. The objective is to maximize infiltration of water produced by dewatering operations consistent with prudent and sound environmental practices and water management objectives for Boulder Valley. Barrick resumed infiltration of water to the rhyolite under this protocol in February 1999. Barrick anticipates that water will be infiltrated to the rhyolite under the protocol during the non-irrigation season.

### 1.4.3.6 Injection

In 1993, Barrick applied to the NDEP for an underground injection control (UIC) permit to authorize Barrick to drill wells in upper Boulder Valley and to inject water from Barrick's ground water pumping operations into the rhyolite formation through the wells. The UIC permit, NEV93207, was issued and Barrick installed the first of five injection wells in April 1994. The permit authorizes Barrick to drill up to 11 injection wells in the injection area and to inject water from the TS Ranch Reservoir or the Sand Dune Canal, so long as the water injected meets the water quality criteria established by the permit. At present, Barrick estimates the capacity of the five existing injection wells at approximately 28,000 gpm on an instantaneous basis. Operating experience indicates that the wells need to be cleaned every 3 to 4 months to remove scale that inhibits injection flows. The locations of the five injection wells are depicted in Figure 1-4.

### 1.4.3.7 Sand Dune Drainage Embankments

In 1995, Barrick entered into an agreement with the U.S. Natural Resources Conservation Service to develop a temporary managed wetland area in the Sand Dune drainage. The temporary managed wetlands project consists of three embankments constructed across the Sand Dune drainage downgradient of the Sand Dune Canal. The embankments were designed and constructed with 3:1 slopes and a 15-foot crest width. The embankments range in maximum height from 8 to 13 feet and in length from approximately 7,600 feet to 9,650 feet. During a projected 25-year, 24-hour storm event, the north embankment would impound a maximum of 244 acre-feet of water creating a pool with a surface area of 155 acres, the middle embankment would impound a maximum of 1,045 acre-feet of water creating a pool with a surface area of 361 acres, and the south embankment would impound a maximum of 2,153 acre-feet of water creating a pool with a surface area of 589 acres. Each of the embankments has spillways that are designed to safely pass the flows that would result from a 100-year, 24-hour storm event.

The temporary managed wetlands provide storage capacity south of the Sand Dune Canal for spring flows and other surface flows during precipitation events or periods of snowmelt. Development of a temporary managed wetlands area was expected to enhance wildlife use and support wetland functions comparable to those supported by the area around the springs in which wetland vegetation has emerged. Following discussions with the NDEP, Barrick submitted a storm water management plan for the Sand Dune Drainage embankments to the NDEP in November 1996. The plan provides that until flows from the springs cease, Barrick will operate its recirculation facilities in Boulder Valley to control the quantity of water equal to the surface flow from the springs. To the extent that the capacity of the recirculation system allows, Barrick also will manage surface runoff from precipitation events and snowmelt. Excess precipitation and snowmelt will flow to the embankments. Barrick will monitor flows into the embankments and will not release from the embankments a quantity of water in excess of the total precipitation and snowmelt flows as determined by runoff modeling using actual precipitation data collected at the site. The NDEP approved the storm water management plan in December 1996. The temporary managed wetland area will be maintained until flows from the springs diminish due to the dissipation of the ground water mound in the rhyolite formation. Since 1996, only minor quantities of runoff from snow and rain events collected in the impoundments, and no water has been released from the south embankment. The embankments were dry during the summer and fall of 1996, 1997, and 1998. The locations and orientation of the three embankments are depicted in Figure 1-5.

#### 1.4.3.8 Humboldt River Discharge

In June 1995, Barrick submitted an application to the NDEP for an NPDES permit to authorize Barrick to discharge water produced by ground water pumping operations to the Humboldt River. The application was modified in December 1995 to increase the quantity of the discharge to 70,000 gpm and to provide for compliance with all Humboldt River water quality standards, except dissolved oxygen and temperature, at the outfall from the treatment facility. The NDEP issued an NPDES permit, NV0022675, to Barrick on July 10, 1996. Barrick and Newmont concluded an agreement allowing Barrick to construct the treatment facility and conveyance system on land owned by Newmont and ELLCO in October 1996, and Barrick initiated construction of the facilities in January 1997. Construction was completed in August 1997 and discharge commenced as irrigation use declined in September 1997.

The treatment facility uses lime treatment and pH adjustment to lower the naturally occurring levels of total dissolved solids, fluoride, and boron in the ground water to levels that are below the Humboldt River water quality standards. The sludges from the treatment process are used as an alternative feedstock for the autoclave neutralization process. Cooling towers are used to lower the water temperature so that the Humboldt River temperature standards and dissolved oxygen standards are met in the river. The NPDES permit authorizes Barrick to discharge to the Humboldt River via Boulder Creek, the White House Ditch, and Rock Creek or upland canals and pipelines. Barrick sought concurrence from the USCOE that construction of an outfall structure to the Humboldt River and stabilization of the Humboldt River bank up- and downstream of the outfall structure comply with the provisions of Nationwide Permits 7 and 13. The Corps issued a concurrence letter with conditions on July 31, 1996.

Barrick constructed a conveyance system composed of buried pipelines and a synthetically lined upland canal from the treatment plant to an outfall at the Humboldt River that is adequate to discharge up to 65,000 gpm of treated water from the ground water pumping operations. Water is diverted from the existing cooling channel at the TS Ranch Reservoir to the treatment plant. Water is conveyed via a buried steel pipeline from the treatment plant to a lined upland canal extending from upper Boulder Valley to the White House Ditch in lower Boulder Valley. The lined canal is approximately 13 miles long and is fenced along the entire length to exclude livestock and wildlife from access to the canal. Wildlife/livestock crossings are provided at 14 sites along the canal, and escape ramps are placed within the canal. Fourteen watering devices for livestock and wildlife are located outside the fenced area along the length of the canal. From the end of the canal, the water flows by gravity through another pipeline to the outfall structure at the Humboldt River. The treatment plant and conveyance systems are depicted in Figure 1-4.

After reaching an agreement with Newmont regarding infiltration at the TS Ranch Reservoir, Barrick suspended operation of the Boulder Valley water treatment plant and discharges to the Humboldt River in early February 1999. Barrick anticipates that use of infiltration and irrigation will be sufficient to manage its dewatering flows without the need for discharge to the Humboldt River, at least until Newmont begins producing water from the Leeville Project. Water management practices at that time will depend on Barrick's dewatering objectives, Newmont's dewatering objectives, and actual pumping experience at the Leeville Project. While Barrick's priority will be to avoid discharges to the Humboldt River if practicable, discharges to the Humboldt River remain a viable water management alternative that may be used in the future.

#### 1.4.3.9 Monitoring

In 1990, Barrick established the BVMP in support of the Water Management Plan submitted by Barrick, Newmont, and ELLCO to the Nevada State Engineer. The BVMP currently monitors water levels at 104 ground water monitoring locations and water quality at 22 wells (see Section 3.2). The BVMP also includes monitoring of 19 surface water monitoring locations. The data collected as part of the BVMP are compiled and reported quarterly in tabular and graphic formats. Copies of the quarterly BVMP reports are provided to the BLM and the Nevada State Engineer. As of the end of 1998, Barrick's ground water pumping operations had drawn ground water levels down by approximately 1,500 feet in the mining area. Water management operations have raised ground water levels in an area around the TS Ranch Reservoir a maximum of 110 feet. Data collected by the BVMP are used by Barrick to calibrate the mathematical model developed to simulate the effects of ground water pumping and water management operations.

In addition to the BVMP, Barrick also conducts monitoring as required by various permits issued by the NDEP and the BLM. This monitoring includes annual site visits to 36 seeps and springs located in the Tuscarora Mountains. During each of the seep and spring inventories, site conditions are evaluated, flows are measured, vegetation transects are monitored and water samples are collected for analysis. The data collected during the annual monitoring are compiled and presented in a report submitted to the BLM. The location of the seeps and springs monitored by Barrick are described in Section 3.2.

As provided in the USCOE's concurrence with Nationwide Permit coverage for the outfall structure to the Humboldt River, Barrick has agreed to cooperate with the U.S. Fish and Wildlife Service's (USFWS's) efforts to implement an aquatic biota monitoring study on the Humboldt River. The monitoring program provides for collection of aquatic biota samples (including bird eggs, juvenile bird livers, fish, and invertebrates) from a series of monitoring locations beginning near Elko and extending to the Humboldt Sink. In addition, water quality and quantity data will be collected and provided to the USFWS by Barrick, the Nevada Department of Conservation and Natural Resources, and the USGS. The USFWS will analyze the data collected and prepare a report by the year 2000.

#### 1.4.3.10 Water Management Plans

Based on present mine plans, Barrick's objective is to lower the ground water levels in the area of the Betze-Post and the Meikle mines to 3,576 feet amsl (Barrick 1998c). Once this target ground water level is attained, Barrick intends to reduce ground water pumping rates to a level that will maintain the ground water level at that elevation. Barrick projects that the pumping rate to maintain this ground water level will be approximately 40,000 gpm diminishing to approximately 15,000 gpm. Barrick will continue to pump at the maintenance rate until mining of the Betze-Post and Meikle mines is completed; current mine plans project mining to be completed by approximately 2010. Following completion of mining, Barrick will pump at rates ranging from 2,000 to 4000 gpm to supply milling and processing needs for up to 10 additional years to complete milling and beneficiation of stockpiled ore (Barrick 1999b).

Barrick presently anticipates that water will continue to be used for mining and milling purposes, and delivered to Boulder Valley for irrigation during the irrigation season. Water that is not used for mining, milling, or irrigation purposes would be infiltrated. If excess dewatering water could not be infiltrated, it would be treated and discharged to the Humboldt River through 2006. The capacity of infiltration, injection, irrigation, and other beneficial uses to receive ground water produced by Barrick may be limited by Barrick's delivery of ground water flows from the springs in Boulder Valley to those uses, by regulatory and other legal restrictions, and by other binding obligations to third parties. As a result, the water management operations described in this section are likely to be used concurrently, and in varying combinations, as circumstances require.

Barrick is continuously updating its water management plans and operations, based on its ongoing ground water monitoring program; the hydrologic model used to refine the water management plan is updated at least annually. Therefore, although the operations are continuously refined, the impact analysis in this SEIS is considered a realistic scenario of ground water pumping and disposal of excess mine dewatering water.

## 1.5 Water Management Alternatives

Several alternative water management options have been identified by the BLM and Barrick. Due to the extent and diversity of the water management operations presently employed by Barrick, the alternatives considered tend to involve similar management methods, but applied in different locations.

### 1.5.1 Additional Irrigation

Additional arable land exists in Boulder Valley, some of which has been subject to pivot irrigation in the past (e.g., Mack Farms). Development of additional irrigation would require the consent of the landowner. Also, Barrick's projected ground water production indicates that the capacity of the existing irrigation system in Boulder Valley will exceed projected ground water production during the summer of 2000 and in subsequent years. As a result, development of additional irrigation capacity in Boulder Valley would not be practical unless water produced during the winter could be stored for summer delivery to irrigation.

Barrick has acquired arable land outside of Boulder Valley that is presently irrigated using flood irrigation methods. However, this land is located more than 20 miles from the Goldstrike property, at a higher elevation and in a different hydrologic basin. The cost of constructing a pipeline and operating a pumping system to this land would be prohibitive, and the potential use of the land is limited by projected water production and potential water rights and permitting issues.

### 1.5.2 Additional Infiltration or Injection

Barrick evaluated the potential to infiltrate water in areas of Boulder Valley that are not thought to be hydrologically connected to the Boulder Valley springs. The primary area investigated was along the Sheep Creek Mountains on the western border of Boulder Valley. Based on several wells drilled in the area, Barrick determined that ground water levels and permeability of the rock made the area unsuitable for additional infiltration or injection of water.

Barrick also determined that infiltration of water upgradient of the area being dewatered is not practical. The hydrologic characteristics of the rocks situated east of the Post Fault are very different than the hydrologic characteristics of the rocks in the highly transmissive area between the Post and Siphon Faults. Pumping experience demonstrates that wells in the highly transmissive area can produce from 2,500 to 3,000 gpm, while wells in the area to the east of the Post Fault produce only 50 to 300 gpm. Within the highly transmissive area, the hydraulic gradients are virtually flat throughout the hydrologic compartment. As a result, infiltration of water into rocks outside of the highly transmissive area is not practical because the rocks are not able to take water at a rate comparable to the rate of production from the highly transmissive area. Infiltration of water in the highly transmissive rocks is not practical because it would almost immediately flow back to the pumping center, requiring substantially higher pumping rates, and the related energy and equipment costs, to achieve and maintain the target ground water elevations.

### 1.5.3 Discharge to Other Surface Waters

All surface waters in the Boulder Valley basin ultimately drain to the Humboldt River. The surface water drainages typically have greater channel capacity in the upper reaches, but tend to lose channel definition as the creeks cross the alluvium in Boulder Valley due to infiltration to the alluvium. As a result, there are no natural surface drainages that have adequate capacity to carry the quantity of discharge authorized by Barrick's

NPDES Permit. In any event, any water that would be discharged to these surface waters would ultimately drain to the Humboldt River.

### 1.5.4 Other Water Uses

Barrick has been approached by various entities and agencies regarding other potential beneficial uses of the water produced by the ground water pumping operations. For example, the Pershing County Water Conservation District has contacted Barrick to determine whether delivery of the water to the Argenta Pasture, which is presently owned by the U.S. Bureau of Reclamation and leased to the District, would be feasible. The District has not developed any specific plans for the Argenta Pasture at this time. Thus, while delivery of the water to the pasture is possible, there are numerous land use, land ownership, water rights and permitting issues that would need to be addressed before a plan could be implemented. The Bureau of Reclamation is preparing an environmental impact statement to evaluate the potential transfer of the Rye Patch Project, including the Argenta Pasture, to the Pershing County Water Conservation District. Information on that process can be obtained from the Bureau of Reclamation, Carson City, Nevada.

## 1.6 Existing Mitigation Commitments - Betze Record of Decision

The Record of Decision for the Betze Project Plan of Operations, issued on June 14, 1991, contained monitoring and mitigation stipulations. The stipulations described in this section were developed to monitor and mitigate the potential effects of Barrick's water management operations. These mitigation measures are considered in assessing the potential environmental effects of Barrick's ground water pumping and water management operations in this Supplemental EIS. Additional mitigation measures are identified and evaluated, as appropriate.

### 1.6.1 Monitoring Programs

In 1990, Barrick established the BVMP in support of the Water Management Plan submitted by Barrick, Newmont, and ELLCO to the Nevada State Engineer. The BVMP includes water level measurements at 104 ground water monitoring locations and water quality sampling at 22 wells. The BVMP also includes monitoring of 19 surface water monitoring locations. The BVMP data are compiled and reported quarterly to the BLM and the Nevada State Engineer. BVMP data are also used by Barrick to calibrate the mathematical model developed to simulate the effects of ground water pumping and water management operations.

In addition to the BVMP, Barrick also monitors surface and ground water quantity and quality as required by NDEP and the BLM. Barrick initially identified 19 seep and spring sampling locations that have been monitored annually since 1991 to evaluate flow rate, water quality, and vegetation. These sampling locations are situated along the crest and flanks of the Tuscarora Mountains to the east of the Goldstrike property. In addition, beginning in 1995 Barrick initiated monitoring of an additional 17 stream, seep, and spring sampling locations that are situated north and west of the Goldstrike property. The results of each year's monitoring are compiled in a written report and presented to the BLM. Barrick will continue the seep and spring monitoring program during the period of active mine operations until the year 2030, 20 years after mining is projected to be completed.

As provided in the USCOE's concurrence with Nationwide Permit coverage for the outfall structure to the Humboldt River, Barrick has agreed to cooperate with the USFWS's efforts to implement an aquatic biota monitoring study on the Humboldt River. The monitoring program provides for collection of aquatic biota samples (including bird eggs, juvenile bird livers, fish, and invertebrates) from a series of monitoring locations beginning near Elko and extending to the Humboldt Sink. In addition, water quality and quantity data are collected and provided to the USFWS by Barrick, the Nevada Department of Conservation and Natural Resources, and the USGS. The USFWS will analyze the data collected and prepare a report in the year 2000.

Barrick agreed to conduct monitoring of surface waters, ground water observation ports, process solutions as required by other permits and approvals granted by state agencies, and to provide the results of this monitoring to the BLM. In order to ensure that the BLM had adequate funding for monitoring following closure of the Betze-Post Pit, Barrick established a $250,000 trust fund in 1991 to pay for monitoring of potential environmental impacts of operations at the Betze-Post Pit after December 31, 2030. In the year 2080, or earlier if the BLM determines that long-term monitoring is no longer required, the remaining funds are to be transferred to the long-term mitigation fund (see below).

### 1.6.2 Mitigation Measures

The Record of Decision for the Betze Project Plan of Operations (BLM 1991d) and the Meikle Mine EA Finding of No Significant Impact and Decision Record (BLM 1994c) contain the following environmental protection measures developed to mitigate the potential effects of Barrick's water management operations.

- Wetland Mitigation Fund and Monitoring. In 1991, Barrick established a trust fund of $660,000, which has grown to over $890,000, that is available to the BLM to pay for the onsite or offsite protection or enhancement or replacement of riparian and wetland areas.

- Riparian Vegetation. In addition to the mitigation fund and monitoring of seeps and springs, Barrick committed to spend up to $40,000 to purchase and plant seedlings or container plants in riparian or wetland areas to accelerate revegetation of areas adversely affected by Barrick's ground water pumping and water management operations. These committed funds have not been spent and are still fully available

- Wildlife Water Sources. Barrick committed to contribute up to $50,000 to assist the BLM and the Nevada Division of Wildlife (NDOW) in acquiring and installing alternative sources of water for wildlife in the area that may be affected by Barrick's ground water pumping and water management operations. To date, $50,000 has been spent to purchase and install guzzlers for wildlife use.

- Sage Grouse Habitat Improvements. Barrick agreed to contribute up to $50,000 to assist the BLM with habitat improvement projects for sage grouse to mitigate potential impacts from Barrick's mining or ground water pumping and water management operations. To date, $1,500 has been invested in seeding burn areas to maintain the native grasses and avoid cheatgrass invasion.

- Mule Deer Habitat Improvements. Barrick agreed to contribute up to $125,000 to assist the BLM with habitat improvement projects for mule deer to mitigate potential impacts from Barrick's mining or ground water pumping and water management operations. To date, approximately $123,000 has been invested in seeding, overseeding, and fencing specified areas in order to improve mule deer habitat.

- Pit Water Studies. Barrick committed to fund research of issues related to postmining pit water quality at $50,000 per year for 10 years. The BLM solicited research proposals and funded a 3-year study by the University of Nevada-Reno that was completed in 1995. The BLM recently selected a second research proposal from the University of Idaho.

- Long-term Mitigation Fund. In 1991, Barrick established a $1 million trust fund, which has grown to over $1,535,000, that is available to the BLM to pay for the review, monitoring, or mitigation of potential impacts from Barrick's operations that were not specifically addressed in the mitigation stipulations or reclamation plan for the Betze Project. To date, none of these funds have been expended.

## 1.7 Interrelated Projects

Interrelated projects are defined in this Supplemental EIS as those activities that could interact with Barrick's water management operations or Barrick's proposed buried pipeline (the Proposed Action) in a manner that would result in cumulative impacts. Cumulative impacts are those effects on the environment that result from the incremental impact of Barrick's operations when added to the impacts of past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or private entity undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time (40 CFR 1508.7). As specified in the document Considering Cumulative Effects under the National Environmental Policy Act (Council on Environmental Quality 1997), cumulative effects must be evaluated along with direct and indirect effects. BLM Instruction Memorandum NV-90-435 specifies that impacts must first be identified for Barrick's projects before cumulative impacts with interrelated projects can occur.

The geographic area for cumulative impacts is determined primarily by the location of the projects that are being considered in the analysis as well as the type of resource potentially affected. In the case of this Supplemental EIS, the interrelated projects associated with Barrick's water management operations comprise other projects with the potential for cumulative hydrologic or water quality impacts associated with ground water drawdown, ground water mounding, and/or surface water discharge. The interrelated projects associated with the buried pipeline (Proposed Action) would comprise surface-disturbing actions; no interrelated projects were identified for the Proposed Action.

Under the direction of the BLM, a technical report was prepared that analyzes the potential cumulative impacts of the water management operations of the Goldstrike Mine (including the Betze-Post Pit and the Meikle Mine); the South Operations Area Project Amendment (SOAPA), which is an expansion of the Gold Quarry Mine; and the proposed Leeville Mine. The analysis is based on projections of the Newmont (Hydrologic Consultants, Inc.) and Barrick (McDonald Morrissey Associates, Inc.) hydrogeological models, as well as the effects of other past, present, and reasonably foreseeable future actions potentially affecting ground water and surface water resources within the area of effect, including the Humboldt River.

Resources addressed in the cumulative analysis include geology, ground and surface water resources, riparian areas and wetlands, terrestrial wildlife, aquatic habitat and fisheries, special status species, livestock grazing, socio-economics, and Native American religious concerns. This report is on file at the BLM Field Office in Elko, Nevada, and the results are summarized in this Supplemental EIS.

## 1.7.1 Water Management Operations

Interrelated projects are defined in this Supplemental EIS as those activities that could interact with water management operations of the individual projects in a manner that would result in cumulative impacts. Interrelated mining projects are summarized below and in Tables 1-4 and 1-5; project locations are shown in Figure 1-6.

### 1.7.1.1 Mining Operations

The Carlin Trend mining area of Nevada extends from the Hollister Mine, approximately 38 miles northwest of Carlin, to the Rain Mine, approximately 10 miles southeast of Carlin (see Figure 1-6). Mineral exploration and development has been ongoing within the Carlin Trend since the 1870s, with most of the activity occurring since approximately 1980 (BLM 1993b).

Based on past and planned future dewatering activities, and the ground water modeling conducted for the Goldstrike, Gold Quarry, and proposed Leeville mines, these three operations would have potential cumulative ground water and surface water impacts associated with ground water drawdown and mounding. Four mining operations would have potential cumulative impacts associated with dewatering discharges to the Humboldt River; these operations are the Goldstrike Mine, Gold Quarry Mine, Lone Tree Mine, and the proposed Leeville Mine. The locations of these projects are shown in Figure 1-6. The operation of these mines together with continuing irrigation and other demands for Humboldt River water comprise past, present, and reasonably foreseeable future actions with potential cumulative impacts. These projects are summarized in the following sections and in Tables 1-4 and 1-5. Project locations are shown in Figure 1-6.

## Table 1-4

## Dewatering and Water Management Summary Table

(summary of historic and projected future maximum dewatering rates and drawdown from the Goldstrike Mine, Gold Quarry Mine, and proposed Leeville Mine)

| | | Goldstrike Mine | | Gold Quarry Mine | | Leeville Mine |
|---|---|---|---|---|---|---|
| | Units | Betze Project EIS (1991) | Most Recent Estimates | SOAP EIS (1993) | Proposed Action | Proposed Action |
| Pumping Periods and Rates | | | | | | |
| Start Year (Pumping for Water Supply) | Year | ~1988 | 1987 | 1988 | 1988 | 2000 |
| Start Year (Active Dewatering) | Year | N/A | 1990 | 1994 | N/A | 2000 |
| Planned End Year (Active Dewatering) | Year | 2000 | 2010 | 2001 | 2012 | 2018 |
| Maximum Projected Dewatering Rate | gpm | 29,300 | 69,000 | 42,000 | 25,000 | 25,000 |
| Planned Post Mining Pumping Period (for Water Supply) | StartYear/EndYear | 2000-2010 | 2010-2020 | 2002-2009 | 2012-2017 | None |
| Average Post Mining Pumping Rate | gpm | 4,500 | 2000 | N/A | 2,500 | None |
| Drawdown | | | | | | |
| Estimated Premining Ground Water Surface at Mine | Feet amsl | ~5,300 | 5,265 | ~5,050 | 5,100 | 5,267 |
| Ground Water Elevation End of 1998 at Mine | Feet amsl | N/A | 3,738 | N/A | 4,442 | 4,907 |
| Maximum Drawdown End of 1998 | Feet | N/A | 1,527 | N/A | 658[1] | 360[2] |
| Projected End of Mining Ground Water Surface Elevation | Feet amsl, at mine | 4,140 | 3,576 | 4,275 | 3,725 | 3,800 |
| Maximum Planned Drawdown | Feet, at mine | 1,160 | 1,689 | 775 | 1,375[1] | 1,467 |
| Pumped Volume | | | | | | |
| Pumped Volume as of End of 1998 | Acre-feet | N/A | 621,000 | N/A | 156,000 | 0 |
| Total Projected Future Pumped Volume 1999 through End of Mine[3] | Acre-feet | | 464,000 | | 439,000 | 306,000 |
| Total Planned Pumped Volume At Closure[3] | Acre-feet | 285,000 | 1,085,000 | ~500,000 | 595,000 | 306,000 |
| **Reinfiltration Volume** (injection, infiltration at ponds and during irrigation) | | | | | | |
| Project Reinfiltration Volume End of 1998 | Acre-feet | N/A | 391,000 | N/A | N/A[4] | 0 |

## Table 1-4 (Continued)

| | | Goldstrike Mine | | Gold Quarry Mine | | Leeville Mine |
|---|---|---|---|---|---|---|
| | **Units** | **Betze Project EIS (1991)** | **Most Recent Estimates** | **SOAP EIS (1993)** | **Proposed Action** | **Proposed Action** |
| Total Projected Future Infiltration Volume 1999 through End of Mine | Acre-feet | N/A | 173,000 | N/A | N/A[4] | 212,000 |
| Total Project Reinfiltration Volume | Acre-feet | N/A | 564,000 | 18,500 | N/A[4] | 212,000 |
| Pit Lake | | | | | | |
| Projected Water Level of Recovered Pit lake | Feet amsl | N/A | 5,196 | 5,050 | 5,091 | N/A |
| Predicted Area of Recovered Pit Lake | Acres | N/A | 985 | 190 | 400 | N/A |
| Predicted Volume at Recovery | Acre-feet | N/A | 405,000 | N/A | 175,000 | N/A |
| Estimated Avg. Evaporation at Recovery | Acre-feet/year | N/A | 2,900 | 627 | 1,117 | N/A |

Sources: Barrick 1998c, 1999b; Newmont 1999a, 1998; HCI 1999b; MMA 1998; Radian International and Baker Consultants, Inc. 1997a; BLM 1991a, 1993b.

[1] Includes approximately 76 feet of drawdown that occurred from pumping between 1988 and 1992.

[2] Drawdown has resulted from pumping at the Goldstrike and Gold Quarry mines.

[3] Includes postmining pumping.

[4] Reliable estimates are not available; preliminary estimates suggest volumes on the order of 4,700 (through the end of 1998), 12,000 (1999-End of Mine), and a total volume of 16,700 acre-feet.

N/A = Not applicable or not available.

## Table 1-5
## Humboldt River Discharge Summary
## (summary of historic and projected Humboldt River discharge from the Goldstrike Mine, Gold Quarry Mine, proposed Leeville Mine, and Lone Tree Mine)

| | Units | Goldstrike Mine | | Gold Quarry Mine | | Leeville Mine | Lone Tree Mine |
|---|---|---|---|---|---|---|---|
| | | Betze Project EIS (1991) | Most Recent Estimates | SOAP EIS (1993) | Proposed Action | Most Recent Estimates | Most Recent Estimates |
| Discharge Summary | | | | | | | |
| Discharge Location | | None | Humboldt River | Lower Maggie Creek | Lower Maggie Creek | Humboldt River (Barrick Discharge Outfall) | Iron Point Relief Canal to Herrin Slough Tributary to Humboldt River |
| State Date | Month/Year | N/A | Sept. 1997 | April 1994 | April 1994 | 9/2000 | May 1992 |
| Planned or Projected End Date | Year | N/A | March 1999[1] | 2002 | 2011 | 2003[1] | 2006 |
| Discharge Rate | | | | | | | |
| Estimated Maximum Rate | gpm | 0 | 56,810 | 46,500 | 23,800 | 25,000 | 70,400 |
| Permitted Rate | gpm | 0 | 70,000 | 46,500 | 46,500 | [2] | 75,000 |
| Period of Peak Discharge | Year, Month(s) | N/A | 4th Quarter 1997 | Fall, Winter 1999-2001 | 2000 | 2001 | 2006 |
| Discharge Volume | | | | | | | |
| Total Discharge Volume through 1998 | Acre-feet | 0 | 72,000 | N/A | 77,000 | 0 | 243,000 |
| Total Projected Future Discharge Volume 1999 through End of Mine | Acre-feet | N/A | 9,000 | N/A | 365,000 | 47,000 | 686,000 |
| Total Planned Discharge Volume | Acre-feet | 0 | 81,000 | ~300,000 | 442,000 | 47,000 | 929,000 |

Sources: Barrick 1998c, 1999b; Newmont 1999a, 1998; HCI 1999b; MMA 1998; Radian International and Baker Consultants, Inc. 1997a; BLM 1991a, 1993b.

[1] Based on most recent projection; discharge could occur after this date.

[2] Leeville discharge will be at the Barrick outfall, under Barrick's discharge permit.

N/A = Not Available or Not Applicable.

Table 1-5 summarizes both the historic and projected future dewatering and water management activities for the Goldstrike Mine, Gold Quarry Mine, and proposed Leeville Mine. The historic activities extend from the initiation of ground water pumping for the mines through the end of 1998. The projected future dewatering and water management activities extend from 1999 through the currently projected end date forground water pumping and water management activities for each operation. The values presented under the columns labeled "Most Recent Estimates" and "Proposed Action" represent the current estimates presented in the source documents listed at the bottom of the table. These estimates and the associated development of these projects are subject to economic and other future variables.

Table 1-5 summarizes the historic and projected future Humboldt River dewatering discharge activities from the Goldstrike Mine, Gold Quarry Mine, Lone Tree Mine, and proposed Leeville Mine. For the Humboldt River, the historic period includes all discharge activities that have occurred through the end of 1998. The projected future discharge information for these four projects is based on recently revised estimates provided by Barrick and Newmont for the Goldstrike, Gold Quarry, Leeville, and Lone Tree mines (Barrick 1999b, 1999c; Newmont 1999a, 1999b). It is important to understand that the analysis of potential future dewatering discharge impacts to the Humboldt River presented in this document is based on earlier estimates of mine dewatering discharge (Riverside Technology, inc. [RTi] 1998). Compared to the earlier estimates (RTi 1998), the current mine discharge scenarios indicate that: (1) the Goldstrike Mine would no longer discharge to the Humboldt River after the first quarter of 1999 (earlier estimates assumed Goldstrike would discharge from 1999 through 2011); (2) the average annual discharge from Gold Quarry would be up to 24 percent greater than earlier projections; the period of discharge (1999-2011) would be unchanged; (3) Leeville would discharge at a similar range of rates for 4 years (through 2003) instead of 19 years; and (4) Lone Tree would discharge for the same period and at similar average rates. Overall, the current scenarios represent a reduction of total future discharge (1999-2018) of approximately 16 percent over the period of 1999 to 2018 compared to earlier estimates. For the purposes of estimating potential impacts to the Humboldt River, this analysis used the slightly higher discharge scenario based on the information provided in the RTi 1998 report. This discharge scenario is considered to be environmentally conservative, since it accounts for higher cumulative discharge rates and a higher cumulative discharge volume.

Mineral exploration is ongoing in the Humboldt River basin, and future project development is subject to the uncertainties of ore body definition and the international gold marketplace. If such projects become more firmly anticipated and planned, their proposed actions and alternatives would likely be subject to appropriate site-specific and cumulative NEPA compliance as determined by lead agencies at that time.

### Gold Quarry Mine

The Gold Quarry Mine is located in the Maggie Creek basin on the eastern slope of the north-south trending Tuscarora Mountains. Gold Quarry is located within Newmont's South Operations Area, approximately 6 miles northwest of the Town of Carlin (Figure 1-6). Newmont submitted an application to amend their operating plan to allow expansion and deepening of the Gold Quarry Mine, and expansion of leaching and waste rock disposal facilities. The BLM is preparing an EIS for the SOAPA; approval of the SOAPA would allow continued mining at Gold Quarry, and continued mine dewatering and discharge to Maggie Creek. Dewatering and discharge activities for the Gold Quarry Mine are summarized in Tables 1-4 and 1-5.

Key elements of Newmont's proposed amendment for water management include:

- Continued ground water pumping to maintain a ground water level below the mine floor at approximately 3,725 feet amsl. Dewatering rates of up to 25,000 gpm are forecast until the year 2011. Following completion of Gold Quarry mining operations, pumping would continue for approximately 5 years at a rate of 2,500 gpm to support process operations.

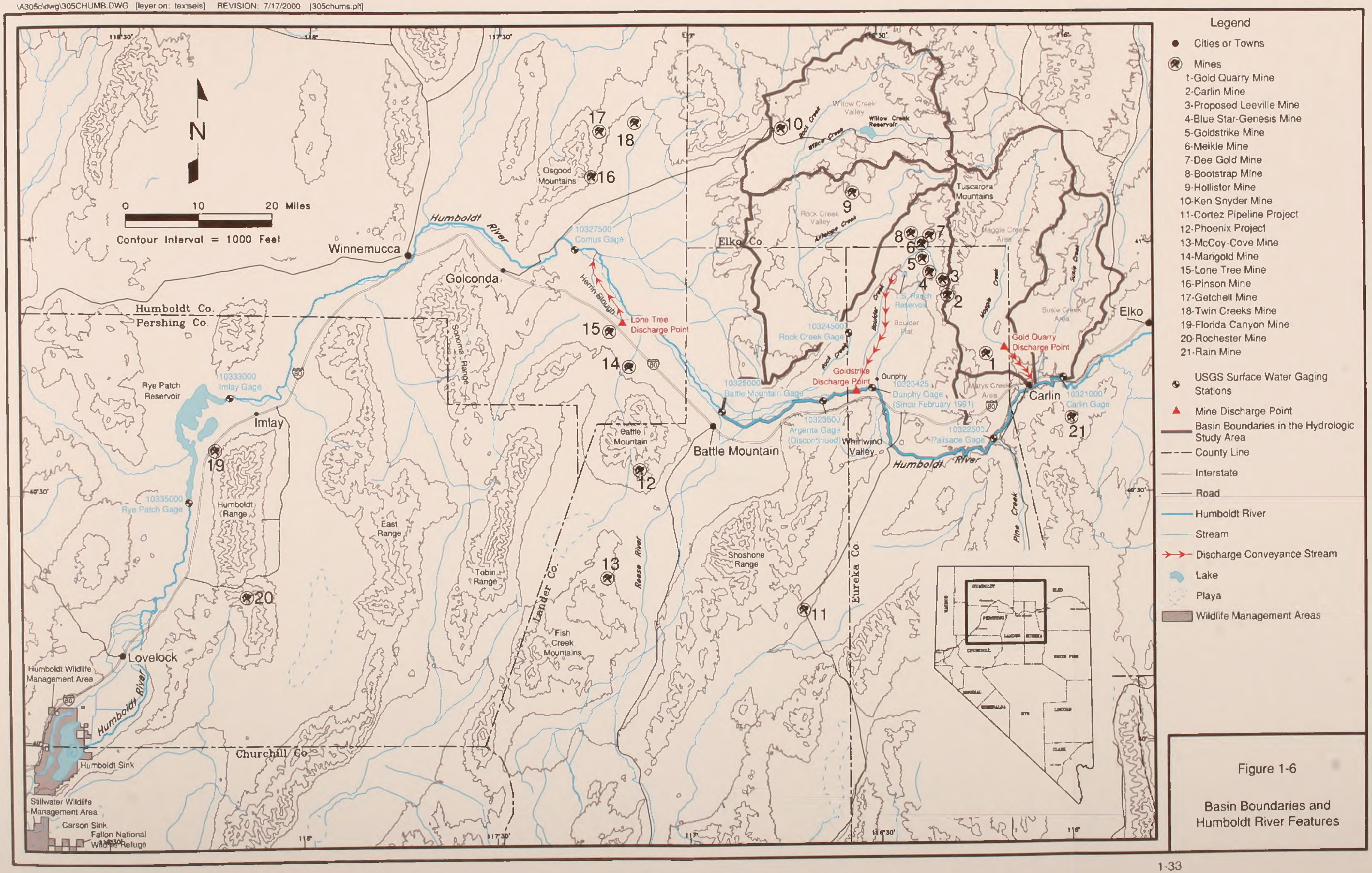

Figure 1-6

Basin Boundaries and Humboldt River Features

- Continued discharge of water into Maggie Creek at a rate of approximately 20,000 gpm in compliance with Newmont's NPDES permit. Maggie Creek drains to the Humboldt River.

- Continued irrigation of Hadley Field.

**Leeville Mine**

Newmont's proposed Leeville Mine is located within the Little Boulder basin on the western flank of the Tuscarora Mountains (Figure 1-6). The Leeville Mine would include development and operation of an underground mine and mine dewatering system, and installation of a water pipeline from the Leeville Mine dewatering well system to the TS Ranch Reservoir. The BLM is currently preparing an EIS for this proposed project. As described in Section 1.2.1, Barrick and Newmont have agreed on the allocation of infiltration capacity and the parameters for infiltration management of water in Boulder Valley, subject to limits based on monitored ground water levels and flow rates in the Sand Dune Canal. If excess water requires discharge to the Humboldt River, Newmont would use Barrick's Boulder Valley discharge outfall. The Leeville Mine is projected to begin mine dewatering in 2000 and continue through an 18-year mine life. The dewatering and discharge activities for the Leeville Mine are summarized in Tables 1-4 and 1-5.

**Lone Tree Mine**

Cumulative impacts to the Humboldt River would result from discharge of dewatering water from the Lone Tree Mine. The Lone Tree Mine is located approximately 34 miles east of Winnemucca south of Interstate 80 (Figure 1-6). Dewatering water that is not consumed is treated to reduce arsenic and is discharged to the Humboldt River via the Iron Point Relief Canal and Herrin Slough, which enters the Humboldt River approximately 11 miles northwest of the Lone Tree Mine. The Lone Tree Mine discharge activities are summarized in Table 1-5.

#### 1.7.1.2 Other Projects and Activities

In addition to mining projects affecting water resources in the Humboldt River basin, the agricultural, domestic, and municipal demands will continue. These sectors comprise the dominant water uses within the basin, and predictions of their needs have varied (Nevada Division of Water Planning 1992a, 1992b, 1998). If demand (water withdrawn for use) or consumption (water not returned to the system after use) increases from these sectors, then the potential for additional impacts on water resources of the basin would occur.

The potential restoration of the Argenta Marsh area is an additional project along the river that would use water resources in the basin. The project is in a preliminary conceptual stage, but it has support from a number of public and private organizations. Water supply, habitat, and land ownership issues need to be examined and resolved before the marsh restoration project can become a reality. During the life of the mines described herein, it is conceivable that additional flows from the mine dewatering discharges of the upstream operations could contribute to the water necessary to reestablish wetland habitats in the Argenta area. Long-term water supply to the marsh restoration project after the cessation of mine dewatering discharges is an issue that remains to be examined. The potential impacts from the restoration project are not further analyzed in this assessment, given that the project is in early conceptual stages and has a number of issues to be resolved before implementation can proceed. If work proceeds on the Argenta Marsh restoration, appropriate environmental analyses will be conducted.

### 1.7.2 Proposed Action

The Proposed Action comprises the construction, operation, and abandonment of Barrick's proposed 4,000-foot buried water pipeline (see Section 2.1). Due to the limited area (18 acres) and short-term disturbance associated with the proposed pipeline, no interrelated projects have been identified as having the potential for cumulative impacts.

## 1.8 Relationship to Policies, Programs, and Plans

As part of the SEIS, the Proposed Action has been evaluated for its conformance with existing land use restrictions imposed by Elko and Eureka counties, the State of Nevada, and minerals decisions in the BLM's Elko Resource Management Plan.

## 1.9 Organization of this Supplemental EIS

The Supplemental EIS is organized to provide both a description of Barrick's existing water management operations and the proposed buried pipeline (Proposed Action), with descriptions of the affected environment and environmental consequences associated with each. Chapter 1 provides the background for the Supplemental EIS, the purpose and need of the Proposed Action and this Supplemental EIS, a description of Barrick's continuing operations, Federal and state authorizing actions associated with the operations, and water management alternatives. Chapter 2 describes the Proposed Action, expansion of an existing right-of-way to accommodate a proposed 3,936-foot buried pipeline. Chapter 3 presents a description of the affected environment and environmental consequences of the ongoing water management operations. Chapter 4 presents a description of the affected environment and environmental consequences associated with the Proposed Action. Chapter 5 summarizes the cumulative impacts identified in the technical report, *Cumulative Impact Analysis of Dewatering Operation for the Betze Project, South Operations Area Project Amendment, and Leeville Project*. Chapter 6 summarizes the consultation and coordination for preparation of the Supplemental EIS; Chapter 7 identifies the list of preparers; and Chapter 8 is a list of references.

# 2.0 PROPOSED ACTION AND ALTERNATIVES

## 2.1 Proposed Action (Buried Pipeline)

Barrick and ELLCO submitted an application to the BLM on May 2, 1997, to amend existing right-of-way N-52388 for a term of 30 years. The amendment seeks to expand the existing right-of-way width from 40 feet to 80 feet to accommodate the installation of a second pipeline consisting of approximately 3,936 feet of 48-inch diameter steel pipe. A temporary use permit would be required for construction. The location of the proposed pipeline (Section 32, T36N, R49E and Section 4, T35N, R49E, Eureka County) is depicted on Figure 2-1. The proposed pipeline would enable Barrick to separate water from the treatment plant that meets the discharge limitations established by the NPDES Permit from water that can be used for irrigation purposes without treatment. Segregating the flows would reduce the treatment costs incurred by Barrick. In addition, the proposed pipeline would eliminate hydraulic constraints that limit the quantity of water that can be delivered to irrigation. This would increase irrigation use of pumped groundwater by approximately 8,000 gpm during peak irrigation periods. Finally, the proposed pipeline would enable Barrick to recirculate water from the Sand Dune Canal to the TS Ranch Reservoir at the same time that water is being discharged to the Humboldt River. The proposed pipeline could convey up to 65,000 gpm and is intended for year-round use.

Prior to pipeline construction, shrubs and large rocks along the pipeline corridor would be removed, and topsoil would be stripped and stockpiled. Track-mounted hoes and backhoe tractors would excavate a trench approximately 90 inches wide to a depth of approximately 6 feet. Pipe would be delivered to the construction site by tractor-trailer rigs and strung along the pipeline corridor. Pipe sections would be laid out and aligned in the trench, and the joints welded. Welded pipeline joints would be inspected prior to backfilling the trench to locate any defects that might affect the integrity of the pipeline.

The proposed pipeline would be buried in a trench with a minimum of 2 feet of cover. The trench would be backfilled and graded to contour with the surrounding surface immediately following installation of the pipeline. Installation of the pipeline would be completed within approximately a 2-week period. The disturbed area would be reclaimed immediately following construction using an BLM-approved seed mix. The proposed seed mixture shown in Table 2-1 includes species adapted for quick establishment; this would minimize the potential for invasion by undesirable non-native species and noxious weeds. After construction and reclamation, disturbance along the pipeline right-of-way would be limited to a 10-foot wide, 2-track access road. Upon termination of discharge operations, the pipeline would be sealed and abandoned in place, and the access road would be ripped and revegetated.

## 2.2 Alternatives to the Proposed Action (No Action)

Under the No Action Alternative, the proposed buried pipeline would not be constructed, and the disturbance described along the 3,936-foot right-of-way in Section 2.1 would not occur. Without the buried pipeline, the operational flexibility of the water distribution system would not be realized; additional water treatment would be necessary, which would increase the quantity of precipitate generated by the treatment process; and less water could be delivered to irrigation uses.

## 2.3 Alternatives Considered but Eliminated from Detailed Analysis

Removing the pipeline following the end of operations was considered as an alternative to abandoning the pipeline in place. This alternative would redisturb the right-of-way following the revegetation and reclamation that would occur immediately after construction. Given that there would be no potential soil, water, or vegetation

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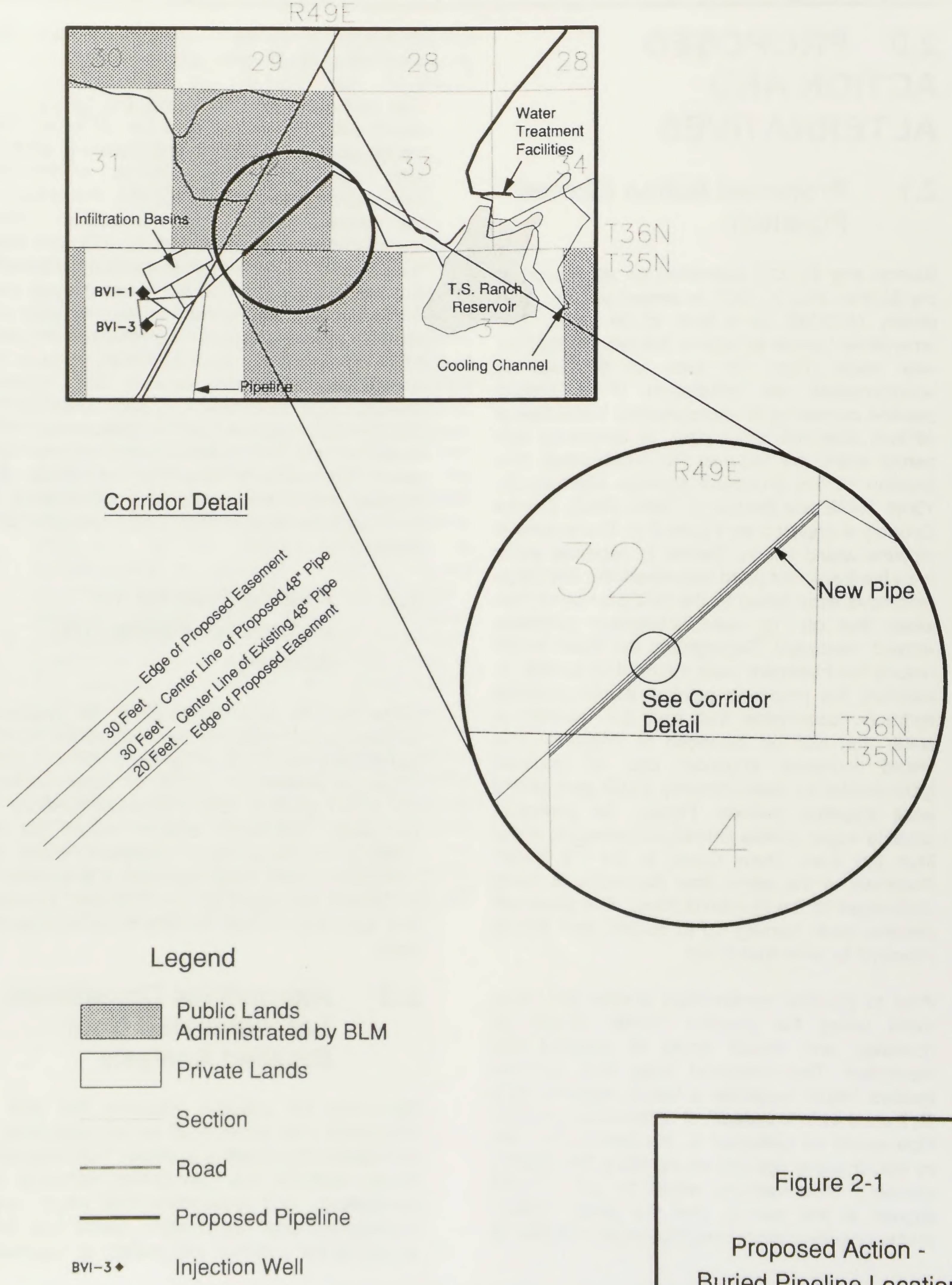

Figure 2-1

Proposed Action - Buried Pipeline Location

Table 2-1

Seed Mixture

| Common Name | Scientific Name | PLS LBS/ACRE |
|---|---|---|
| Bluebunch wheatgrass | *Agropyron spicatum* | 4 |
| Great Basin wildrye | *Elymus cinereus* | 2 |
| Western wheatgrass | *Agropyron smithii* | 4 |
| Thickspike wheatgrass | *Agropyron dasystachyum* | 4 |
| Prostrate kochia | *Kochia prostrata* | 0.5 |
| Lewis flax | *Linum lewisii* | 2 |
| Fourwing saltbush | *Atriplex canescens* | 3.5 |
| **Total** | | **20.0** |

PLS = pure live seed.

impacts associated with leaving the pipeline in place, the redisturbance associated with removing the pipeline would result in increased adverse air quality, soil, vegetation, and wildlife impacts. Therefore, pipeline removal was eliminated from detailed consideration.

## 2.4 Agency Preferred Alternative

In accordance with the National Environmental Policy Act, federal agencies are required by the Council on Environmental Quality (40 Code of Federal Regulations 1502.14[e]) to identify their preferred alternative for a project in the Draft EIS, if a preference has been identified. As discussed in Chapter 1, the Proposed Action for this Supplemental EIS, i.e., the action upon which the BLM will make a decision, is the installation of the buried water pipeline. The BLM has identified the Proposed Action as the agency preferred alternative. The BLM is reviewing monitoring and mitigation measures identified during the analysis of the Proposed Action and Barrick's continuing dewatering and water management operations; the BLM will identify required monitoring and mitigation measures in the Record of Decision for this Supplemental EIS.

# 3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES FOR WATER MANAGEMENT OPERATIONS

This chapter describes the environmental baseline conditions in the area potentially affected by Barrick's ground water pumping and water management activities and the regional study area analyzed in the CIA report (BLM 2000b). The environmental baseline information summarized in this chapter was obtained from published and unpublished materials; interviews with local, state, and Federal agencies; and field and laboratory studies in the project area.

The analysis of impacts from Barrick's water management operations assumes the implementation of existing mitigation commitments and other environmental protection measures by Barrick; these measures are described in Section 1.6 of this SEIS. Most of these committed measures were developed by Barrick and the BLM as part of the Betze Project Record of Decision (BLM 1991d) based on the analyses in the Betze Project Final EIS (BLM 1991b). They encompass a range of short- and long-term monitoring programs and associated mitigation in the event that surface water resources and associated riparian vegetation were affected by Barrick's ground water drawdown. The environmental protection measures include monitoring programs along the Humboldt River, at the Humboldt Sink, and at Barrick's future pit lake for water quality and water quantity issues. The following impact analyses reflect the incorporation of these committed environmental protection measures. Potential additional mitigation and monitoring measures developed in response to anticipated impacts are discussed for each resource in this chapter; these measures could be required by the BLM as stipulations of the Record of Decision. Residual impacts, i.e., those impacts remaining following implementation of the mitigation measures, are identified for each resource. Descriptions of irreversible or irretrievable commitments of resources are provided at the end of each resource section. Cumulative impacts are addressed for each resource in Chapter 5.

This document is a Supplemental EIS; therefore, as stated in 40 CFR 1502.9, this chapter addresses "substantial changes in the proposed action that are relevant to environmental concerns..." and "significant new circumstances or information relevant to environmental concerns and bearing on the proposed action or its impacts." The BLM determined that the following resources could potentially be affected by changes in the Barrick's water management operations; therefore, potential impacts to these resources are analyzed in Chapter 3.

- Geology
- Water Resources
- Riparian Vegetation
- Wildlife Resources
- Aquatic Resources
- Threatened, Endangered, Candidate, and Sensitive Species
- Grazing Management

The BLM's NEPA Handbook (H-1790-1) requires that all EISs address certain Critical Elements of the Human Environment. These critical elements are presented below along with the location in this chapter where the element is discussed. If the element does not occur within the project area or would not be affected, this is indicated below, and the element is not discussed further in the SEIS. This elimination of nonrelevant issues follows the Council on Environmental Quality guidelines as stated in 40 CFR 1500.4.

- Air Quality - would not be affected.

- Areas of Critical Environmental Concern - would not be affected.

- Cultural Resources - would not be affected.

- Drinking Water/Ground Water Quality - refer to Section 3.2.

- Environmental Justice - refer to Section 3.8.

- Floodplains - refer to Section 3.2.

- Hazardous or Solid Wastes - would not be affected.

- Invasive Non-native and Noxious Plant Species - refer to Section 3.3.2 for riparian vegetation.

- Native American Religious Concerns – refer to Section 3.9; refer to Section 5.9 for potential cumulative impacts of mine dewatering.

- Paleontological Resources - would not be affected.

- Prime or Unique Farmlands - would not be affected.

- Threatened, Endangered, Candidate, or Sensitive Species - refer to Section 3.6.

- Wetlands and Riparian Zones - refer to Section 3.3.

- Wild and Scenic Rivers - would not be affected.

- Wilderness - would not be affected.

Numerous technical reports were used as support documents to this SEIS. Copies of these technical reports are available for review at the following location:

- BLM Elko Field Office
  3900 East Idaho Street
  Elko, Nevada 89801

A complete list of the reference documents used in preparing this SEIS is included in Chapter 8.0.

# 3.1 Geology

## 3.1.1 Affected Environment

The geologic conditions in the vicinity of the Goldstrike Mine were summarized in the Betze Project Draft EIS (BLM 1991a). The information provided in this section is intended to supplement the geologic information provided in the original Betze Project Draft EIS. The geologic conditions discussed below provide the information necessary to characterize the hydrogeologic conditions discussed in Section 3.2, Water Resources and Geochemistry.

### 3.1.1.1 Physiographic and Topographic Setting

The topography and physiographic features of the regional study area for geology and minerals are shown in Figure 3.1-1. The regional study area for geology is coincident with the hydrologic model area described in Water Resources and Geochemistry (Section 3.2). The regional study area includes the Boulder Creek, Rock Creek, Willow Creek, Marys Creek, Maggie Creek, and Susie Creek drainage basins. All of these basins are tributary to the Humboldt River, which forms the southern boundary of the study area. Major mountain ranges within the study area include the Sheep Creek Range and portions of the Tuscarora Mountains, Independence Range, and Adobe Range. The elevation ranges from approximately 8,700 feet above mean sea level (amsl) in the Tuscarora Mountains near the central portion of the study area to 4,500 feet amsl along the Humboldt River in the southwest corner of the study area.

The project area is located within the Great Basin region of the Basin and Range physiographic province and is characterized by a series of generally north-trending mountain ranges separated by broad basins. The Basin and Range physiography has developed from normal faulting that began approximately 17 million years ago and continues to the present (Stewart 1980). The extensional block faulting uplifted the mountains, which consist of Precambrian to Tertiary age bedrock units. The basins are filled with thick accumulations of unconsolidated and consolidated sediments that are derived from erosion of the adjacent mountain ranges.

### 3.1.1.2 Regional and Geographic Setting

The regional geologic conditions are presented in Figure 3.1-2, and the regional geologic cross sections are shown in Figure 3.1-3. Both the regional geologic map and cross sections are based on information presented by Maurer et al. (1996). Maurer et al. (1996) simplified the complex geology of the region into six regional map units. From oldest to youngest, these regional units include marine carbonate rocks, marine clastic rocks, intrusive rocks, volcanic rocks, older basin-fill deposits, and younger basin-fill deposits. Table 3.1-1 summarizes the age range, lithologic description, maximum estimated thickness, and lists the formations and other localized map units included within each of these six regional geologic map units.

The study area has undergone a complex geologic history, resulting in variable stratigraphic and structural geologic conditions. During the Early Paleozoic Era, marine clastic and carbonate rocks were deposited on the sea floor along the western continental margin of North America. The marine clastic rocks were deposited farther west, in a deep ocean setting, while the carbonate rocks were deposited in a shallow water setting adjacent to the land mass. The marine carbonate rocks consist of limestone and dolomite with minor shale, siltstone, sandstone, and quartzite. The marine siliciclastic rocks include interbedded metasedimentary mudstones, shale, chert, siltstone, quartzite, and greenstone (Stone et al. 1991). A transitional assemblage lies between the two sedimentary assemblages (Stewart 1980; Schull 1991). In the vicinity of the Carlin Trend, the transitional assemblage consists predominantly of limestones and siltstones. In an attempt to simplify the stratigraphy of this region, Maurer et al. (1996) combined these transitional assemblage rocks with the carbonate assemblage.

During the Late Devonian or Early Mississippian time, marine deposition was interrupted, and the Paleozoic sediments were uplifted, folded, and thrusted by the Antler Orogeny (orogeny is a geologic term for mountain building event) .

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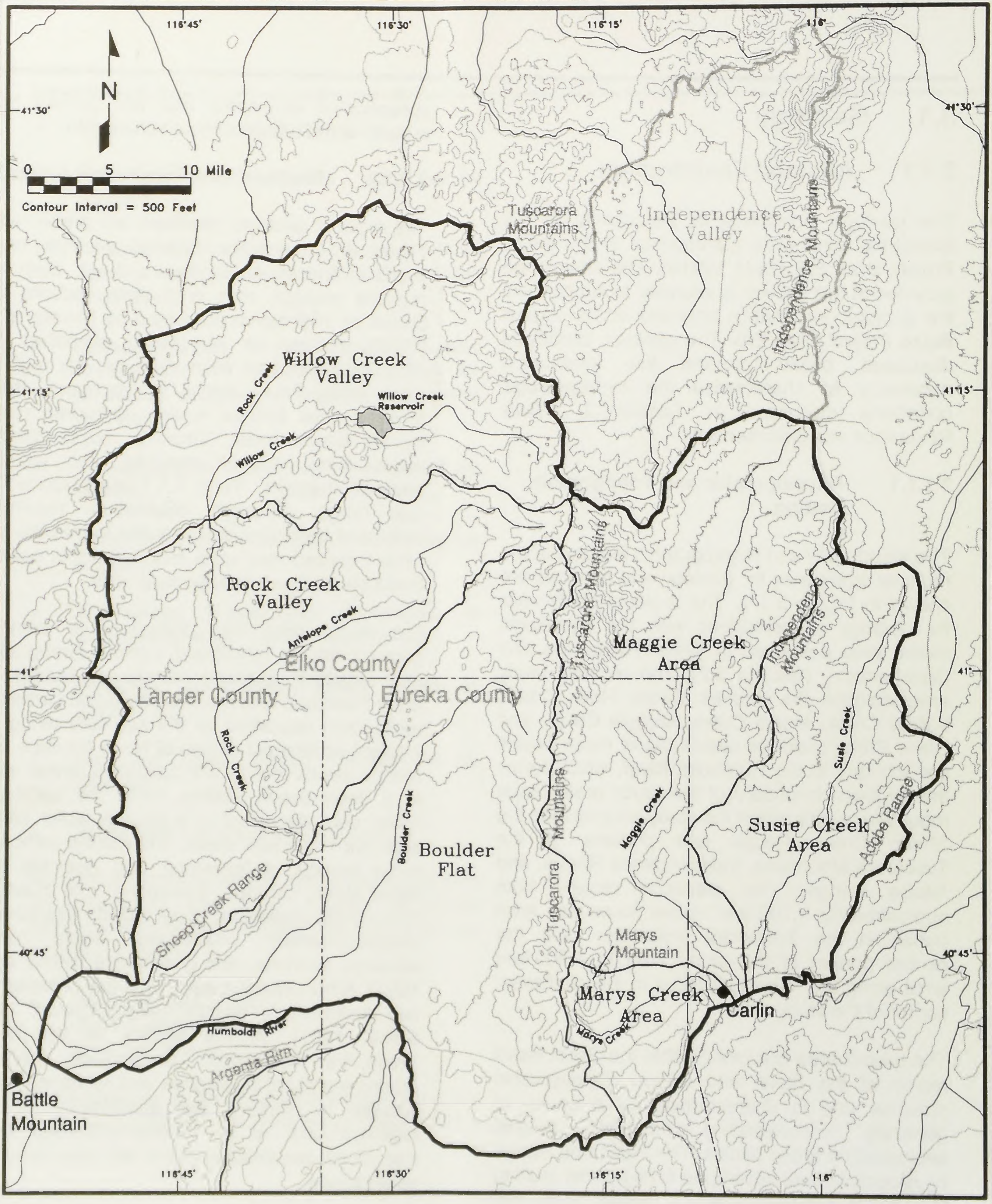

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━ Study Area

— Ground Water Basin Boundary

— Stream

-·- County

Figure 3.1-1

Regional Topographic Map

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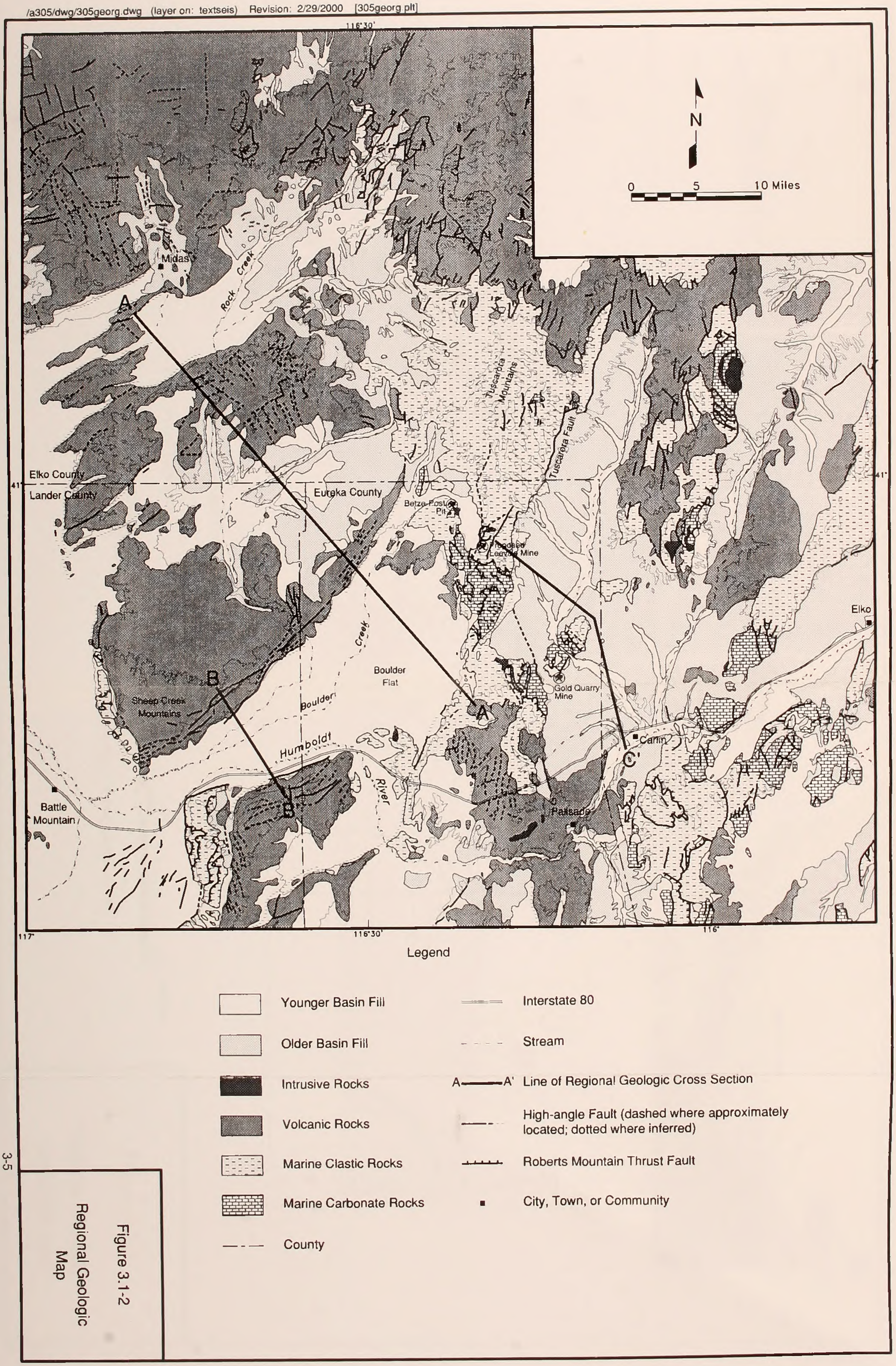

Figure 3.1-2

Regional Geologic Map

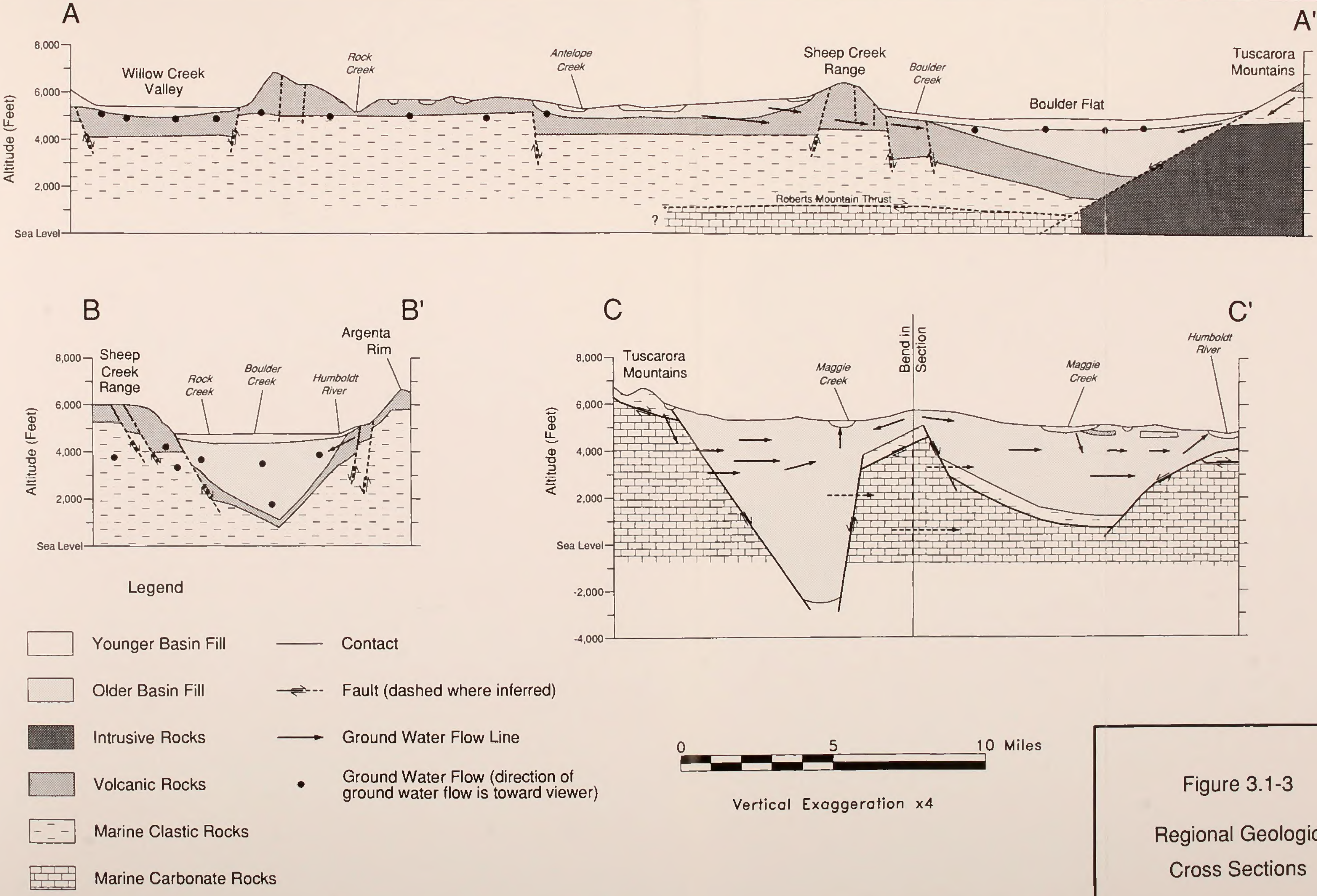

Figure 3.1-3

Regional Geologic Cross Sections

## Generalized Description of the Regional Geologic Map Units

| Hydrogeologic Unit | Geologic Age | Lithology | Rock or Stratigraphic Unit[1] | Maximum Thickness (feet) |
|---|---|---|---|---|
| Younger basin-fill deposit | Quaternary and Tertiary | Deposits of alluvial fans, basin lowlands, and stream flood plains | Includes unnamed deposits and Hay Ranch Formation of Regnier (1960) | 1,600 |
| Older basin-fill deposit | Tertiary and Cretaceous | Shale, claystone, siltstone, limestone, conglomerate, and sandstone; locally tuffaceous | Upper part of Raine Ranch Formation of Regnier (1960); Carlin Formation of Regnier (1960); Humboldt Formation (restricted) of Smith and Ketner (1976); Elko Formation, limestone, conglomerate, and cherty limestone of Smith and Ketner (1976); Rand Ranch Formation of Regnier (1960); Newark Canyon Formation | 7,600 |
| Volcanic rocks | Tertiary and Jurassic | Felsic flows, domes, and ash-flow tuffs; intermediate lava flows, pyroclastic rocks, and air-fall tuffs; mafic volcanic rocks; and ash | Big Island Formation, Banbury Formation, Palisade Canyon Rhyolite of Regnier (1960); Rhyolitic welded tuff of Smith and Ketner (1976); Safford Canyon Formation and lower part of Raine Ranch Formation of Regnier (1960); Indian Well Formation, mafic to intermediate units of Smith and Ketner (1976); and Frenchie Creek Rhyolite | 13,000 |
| Intrusive rocks | Tertiary and Jurassic | Plutons, dikes, and minor plugs of felsic to intermediate composition | Quartz monzonite plutons of Swales and Lone Mountains; also includes large plutons inferred from aeromagnetic data to underlie Marys Mountain and west part of Sheep Creek Range | -- |
| Marine siliciclastic rocks | Paleozoic (Devonian to Ordovician) | Sandstone, chert, shale, and siltstone | Valmy Formation, Vinini Formation, Silurian rocks of Marys Mountain, Elder Sandstone, Woodruff Formation, and Slaven Chert | 23,000 |
| Marine carbonate rocks | Paleozoic (Permian to Mississippian; Devonian to Cambrian) | Mudstone, siltstone, quartzite, limestone, shale, and sandstone | Permian to Mississippian: Tripon Pass Limestone, Webb Formation, argillite of Lee Canyon, Chainman Shale, Diamond Peak Formation, Moleen Formation, Tomera Formation, Carlin Sequence (amended), sandstone and siltstone of Horse Mountain, and Edna Mountain Formation (part of the Antler Sequence)[2] | 26,000 |
| | | Limestone, dolomite, limy siltstone, sandy dolomite, claystone, chert, and quartzite | Devonian to Cambrian: Hamburg Dolomite, Pogonip Group, Eureka Quartzite, Hansen Creek Formation, Ordovician rocks of Marys Mountain, Roberts Mountains Formation, Lone Mountain Dolomite, Popovich Formation, Rodeo Creek unit of Ettner (1989), Nevada Formation, Devils Gate Limestone, and Wenban Limestone | 19,000 |

Source: Maurer et al. 1996.

[1] Stratagraphic units defined in Regnier 1960; Roberts et al. 1967; Smith and Ketner 1975, 1976; Stewart and McKee 1977; Stewart 1980; Radtke 1985; Coats 1987; and Ettner 1989.

[2] The Permian to Mississippian rock or stratigraphic units are included with the marine siliciclastic rocks in Stewart 1980, and Ekburg and Rota 1987. Roberts et al. 1967 states the Diamond Peak Formation is composed principally of siltstone, sandstone, and conglomerate.

During the Antler Orogeny, the siliciclastic rocks were thrust over the carbonate rocks along the Roberts Mountain Thrust (Roberts 1966; Stewart 1980), a major structural feature within the regional study area. The clastic rocks form the upper plate, while the carbonate rocks form the lower plate of the thrust. The marine carbonate rocks underlie the siliciclastic assemblage throughout the study area. Stewart (1980) notes the clastic rocks in the upper plate have been displaced to the east by as much as 90 miles and are composed of interleaved broad, thin thrust sheets that are oriented sub-parallel to the bedding.

The Antler Orogeny also created a highland that persisted during much of the Mississippian period and perhaps during parts of the Pennsylvanian and Permian periods (Stewart 1980). During the Late Paleozoic Era, sediments shed from the highland resulted in deposition of clastic and carbonate rocks (Antler Sequence). These rocks are grouped by Maurer et al. (1996) with the Paleozoic marine carbonate rocks (Table 3.1-1), although the rocks are primarily siliciclastic.

During the Mesozoic and Early Cenozoic Eras, the area was subjected to compression, which resulted in the Tuscarora Mountain anticline and may have fractured the rocks in the vicinity of the anticline, providing pathways for mineral-bearing fluids and ground water. Intrusive igneous activity accompanied this compression. The Marys Mountain intrusive complex, long postulated on the basis of geophysics and recrystallization (Evans 1974), is composed of rocks that span from Jurassic through Tertiary: the outcropping Goldstrike granodiorite is dated at 154-162 million years (Arehart 1992), the outcropping Richmond Mountain quartz monzonite is dated at 106 million years (Evans 1974), and the outcropping Welches Canyon granodiorite is dated at 37 million years (Evans 1974).

Beginning in the late Cenozoic Era, the area was block-faulted by a series of normal and listric faults that created the Basin and Range topography that characterizes the region. Broad valleys in the regional study area, such as Boulder Valley and the Maggie Creek basin, were formed as down-dropped blocks between uplifted mountain ranges. As shown on the project area geologic map, Figure 3.1-4, (Maurer et al. 1996; McDonald Morrissey Associates, Inc. 1998) major normal faults bound the southeast flank of the Sheep Creek Range, the east flank of the Tuscarora Mountains, and the north side of the Argenta Rim. These normal faults drop the basin side down relative to the mountain side, may have displacements of thousands of feet, and are usually at high angles (McDonald Morrissey Associates, Inc. 1996b). Major normal faults within the study area (Figure 3.1-4) are listed below:

- Post Fault, which trends north-northwest
- Fault zone along the southeast margin of the Sheep Creek Range
- Little Boulder Basin Fault, located in the Tuscarora Mountains
- Tuscarora Fault, located on the eastern margin of the Tuscarora Mountains (HCI 1999b)
- Soap Creek fault, located on the western margin of the Independence Mountains (HCI 1999b)

In addition, the Siphon and Boulder Narrows faults were identified by Barrick's hydrogeologic studies (McDonald Morrissey Associates, Inc. 1998).

Uplift and subsequent erosion of the mountains during the late Cenozoic Era have partially filled the basins with poorly consolidated to unconsolidated silty clay, silt, clayey sand, sand, gravel, and boulders deposited primarily as a series of coalescing alluvial fans. These basin-fill deposits are mapped as two types: (1) older basin-fill deposits and (2) younger basin-fill deposits (Maurer et al. 1996).

The older basin-fill deposits are Miocene to Pliocene in age and consist of fluvial and lacustrine sediments, volcaniclastic rocks, and volcanic rocks. In Boulder Flat, the older basin-fill deposits may be as thick as 3,000 feet (McDonald Morrissey Associates, Inc. 1996b), while in the Maggie Creek basin the older basin-fill deposits may be in excess of 5,000 feet (McDonald Morrissey Associates, Inc. 1998).

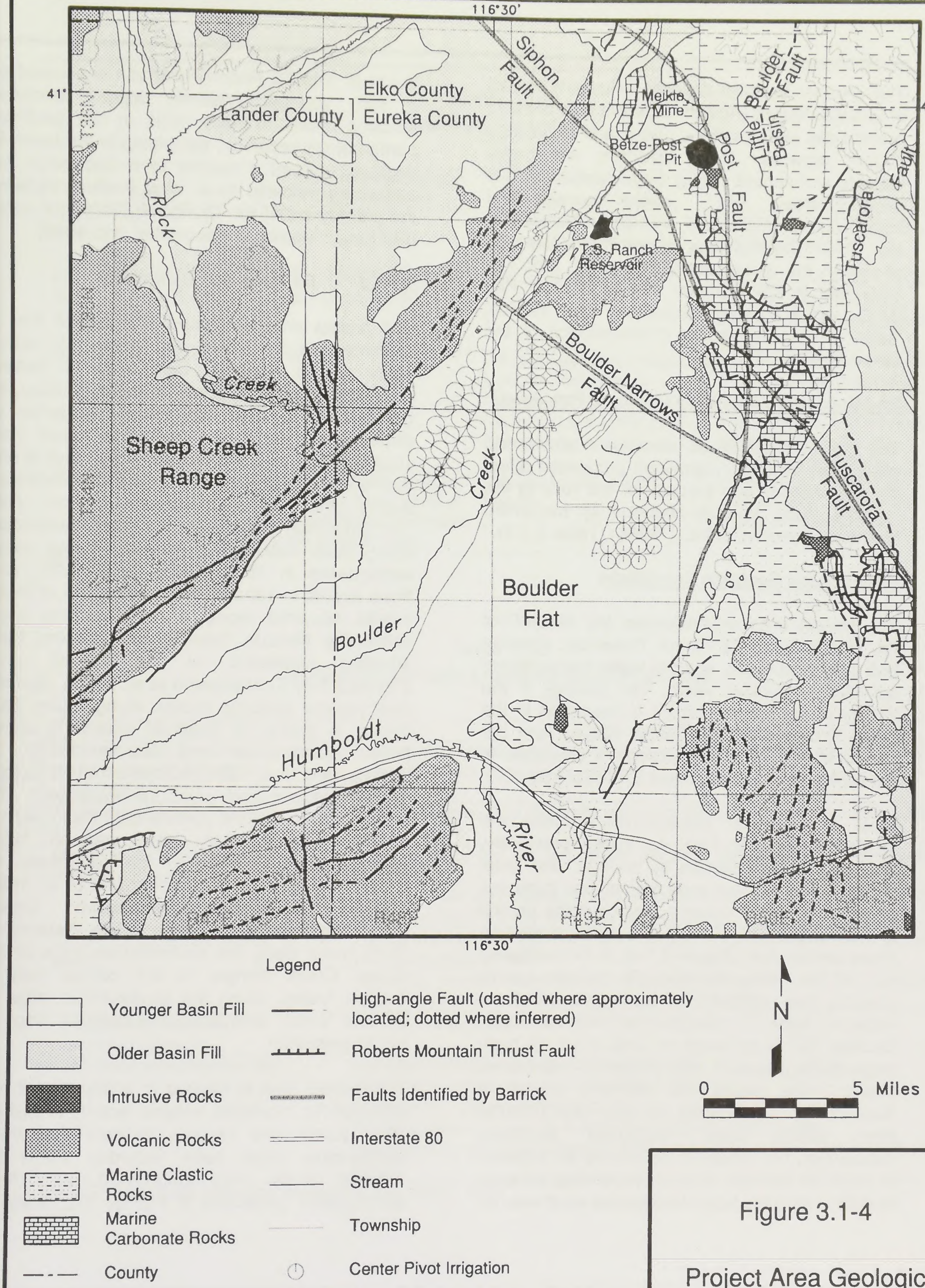

Figure 3.1-4

Project Area Geologic Map

The younger basin-fill deposits (alluvium) consist of unconsolidated alluvium deposits that underlie present-day streams, flood plains, and associated stream terraces. These deposits are highly variable and consist of silty clay, sandy clay, silty sand, clayey sand, gravel sand, and conglomerate (McDonald Morrissey Associates, Inc. 1998). The thickness ranges from a few tens of feet in the mountains (Stone et al. 1991) to 1,000 feet in the southern part of Boulder Flat (McDonald Morrissey Associates, Inc. 1996b). Table 3.1-2 presents the characteristics of the basins in the study area.

#### Structure and Secondary Geologic Processes

The geologic structures discussed above and associated secondary geologic processes affect the permeability and porosity of the rock in the regional study area as reported by McDonald Morrissey Associates, Inc. (1996b) (Table 3.1-3).

#### Project Area Geologic Conditions

The project area encompasses the Betze-Post Pit, Meikle Mine, TS Ranch Reservoir, injection and infiltration areas, and the water management activities in Boulder Valley. The geology in the vicinity of the Betze-Post Pit is described in the Betze Project Draft EIS (BLM 1991a), and the Meikle Mine subsurface geology is described in the Meikle Mine Development EA (BLM 1993a).

Most of the water management facilities are located in Boulder Flat. As stated previously, Boulder Flat is underlain by younger and older basin-fill deposits that have a combined thickness of up to several thousand feet near the central and lower portions of the basin. As illustrated on cross section A-A' (Figure 3.1-3), in the northwest part of the valley the basin-fill deposits overlie volcanic rock, while in the southeast part of the valley the basin-fill deposits overlie intrusive rock. Boulder Flat is bounded on both sides by high-angle faults (Figure 3.1-4). Volcanics and marine clastic rocks bound the northern portion of Boulder Flat. The Boulder Narrows Fault (inferred from drilling data; McDonald Morrissey Associates, Inc. 1998) is marked by an increase in depth to bedrock and corresponding increase in thickness of the basin-fill deposits southwest of the fault. The TS Ranch Reservoir is situated on a thin, younger basin-fill deposit overlying volcanic rocks. In early 1991 in the southern portion of the reservoir, soil-piping in the basin-fill deposits opened a conduit to a fracture in the underlying volcanic rock. This fracture became the primary outlet for TS Ranch Reservoir water (McDonald Morrissey Associates, Inc. 1998).

### 3.1.1.3 Faulting and Seismicity

The project area is located in a region that is characterized by active and potentially active faults and a relatively high level of historic seismicity. For the purposes of this evaluation, an active fault is one that shows evidence of displacement during the Holocene period (last 10,000 years), and a potentially active fault is one that shows evidence of surface displacement during the late Quaternary period (last 150,000 years). Historically, surface displacement along faults occurred in Nevada during major earthquakes in 1869, 1903, 1915, 1932, and three events in 1954 (Stewart 1980). All of these events occurred along a north-trending zone called the Nevada Seismic Belt, located over 40 miles southwest of the project area (Figure 3.1-5) (Dohrenwend et al. 1995). Surface fault rupture typically occurs along active fault traces. A review of maps of potentially active faults (Dohrenwend and Moring 1991a, b; Dohrenwend et al. 1995) indicates that no historic faulting has occurred within the study area. The closest known historic surface fault displacement to the regional study area was in 1915, approximately 60 miles to the southwest. As shown in Figure 3.1-6 (Dohrenwend et al. 1995; National Earthquake Information Center Database), inferred Holocene to late Pleistocene faults occur along the southeastern edge of the Sheep Creek Range, in the central part of Boulder Valley, along the southeastern edge of Boulder Valley, and along the northern edge of the Argenta Rim.

The project area is located in a region that has experienced moderate seismic activity in historic time. Earthquake records indicate that three earthquakes have been recorded within the regional study area (Figure 3.1-6). These earthquakes generated a Richter magnitude of

## Table 3.1-2
## Basin Characteristics

| Basin | Thickness of Basin-fill Deposits (feet) | Structural Characteristics | Bedrock |
|---|---|---|---|
| Upper Maggie Creek Area | 7,000 to 8,000 | Deepest basin that is formed by down-faulted rocks | Paleozoic clastic rock that overlies carbonate rock |
| Lower Maggie Creek (LMC) and Susie Creek Area | LMC - 3,000 to 4,000;<br>Susie Creek - 2,000 | Broad structural basin | Paleozoic clastic rock thrust by the Roberts Mountain thrust over the carbonate rock |
| Willow Creek Valley | < 500 | A relatively narrow basin oriented northeast to southwest | Basin underlain by volcanic rocks on top of Paleozoic clastic rocks |
| Rock Creek Valley | 800 to 2,000 | A relatively shallow, bowl-shaped depression | Basin underlain by volcanic rocks that lie on top of Paleozoic clastic rocks |
| Boulder Flat | Over 2,500; the southwest part of the basin (north of Argenta Rim) is estimated to be 3,500 to 5,000 | Bound by range-front faults | Underlain by 500 feet of volcanic rock, which overlies Paleozoic clastic rocks |

Source: Maurer et al. 1996.

## Table 3.1-3
## Effects of Geologic Events on Rock Properties

| Event | Effect on Rock |
|---|---|
| Antler Orogeny (eastward thrust faults and deformed upper plate) | • Increased horizontal permeability sub-parallel to the bedding of the formation, compared to the vertical permeability. |
| Tuscarora Mountain anticline | • The upper plate rocks dip gently westward; fracturing due to the folding allows fluid pathways. |
| Mesozoic and Cenozoic igneous activity | • Intrusive rocks are not extensively fractured, resulting in an impermeable boundary.<br>• Volcanic rocks may contain extensive fracturing (e.g., rhyolite in the northern part of Boulder Flat) and are highly permeable. |
| Cenozoic high angle normal faults | • Locally high angle faults may create barriers to fluid movement; low porosity and permeability in fault.<br>• Cenozoic normal faults locally offset entire sections of the Paleozoic sedimentary rocks causing juxtaposition of rock types. |
| Hydrothermal fluids and associated pressure | • Increased fracturing and permeability. |
| Associated mineralization and alteration | • Decarbonatization – locally increases porosity.<br>• Silicification – decreases porosity of host rocks.<br>• Argillization – decreases permeability.<br>• Dolomitization – may result in formation of pores and fissures.<br>• Dissolution by hot mineral-bearing fluids - increases permeability in carbonate rocks. |

Sources: McDonald Morrissey Associates, Inc. 1996b, 1998.

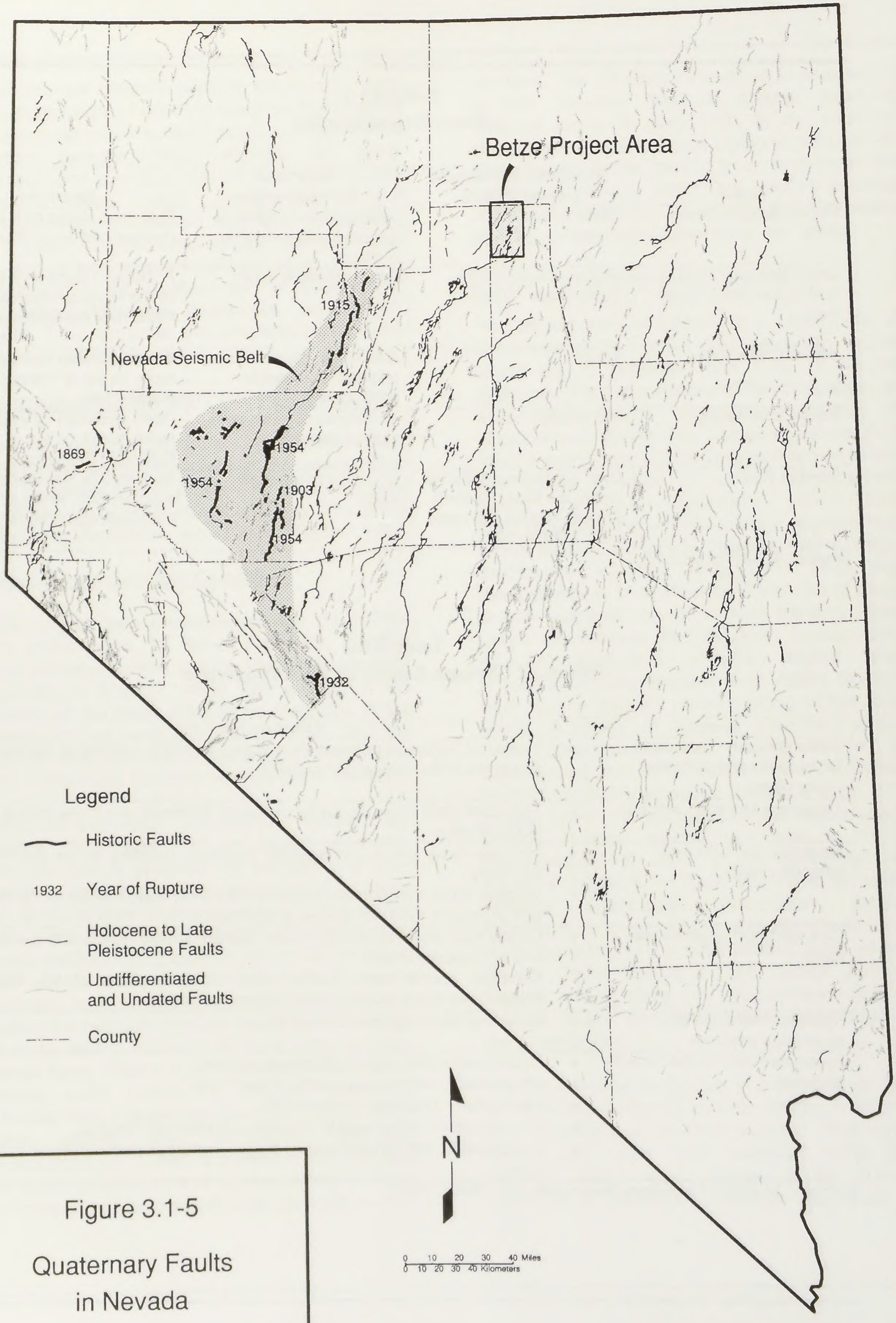

Figure 3.1-5

Quaternary Faults in Nevada

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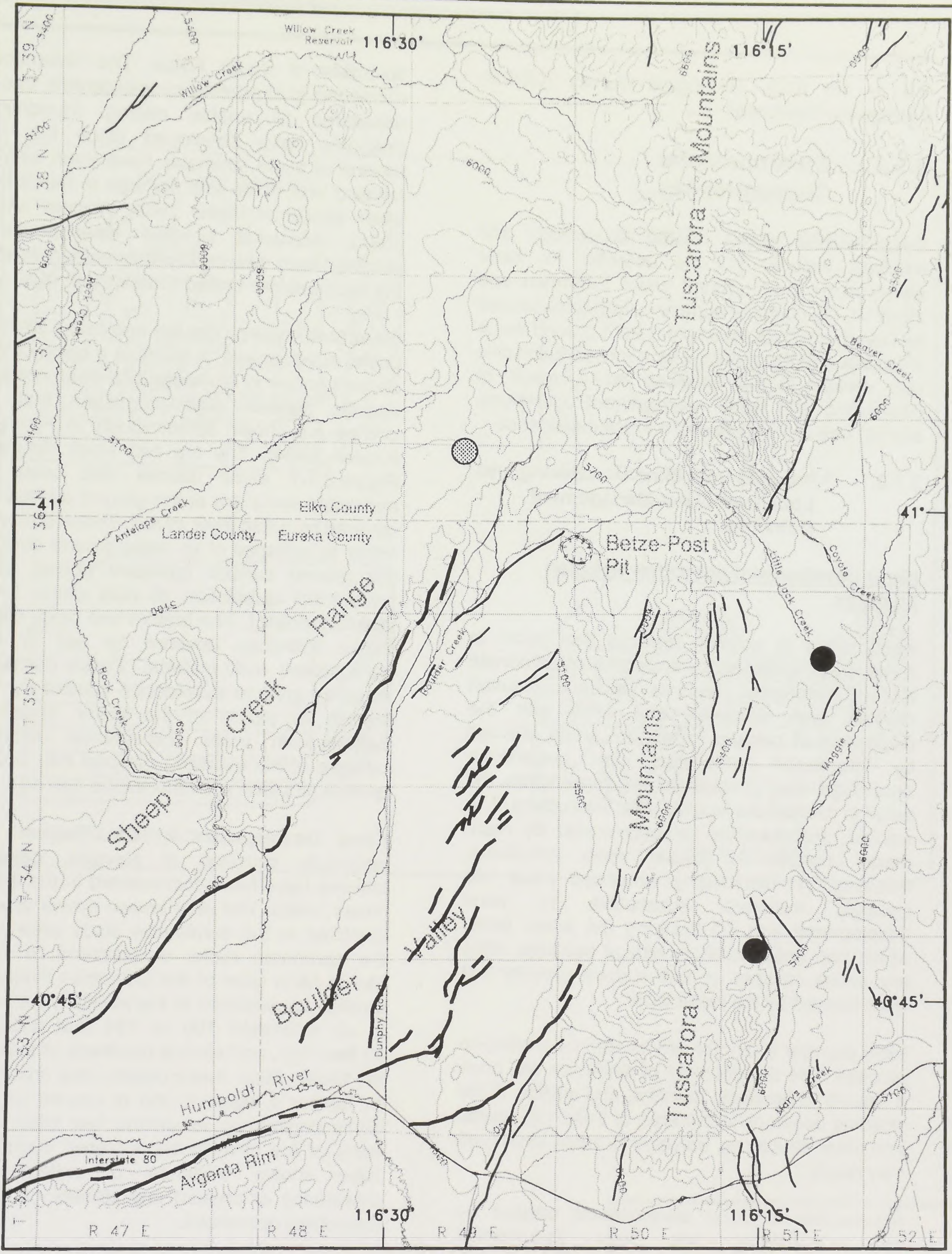

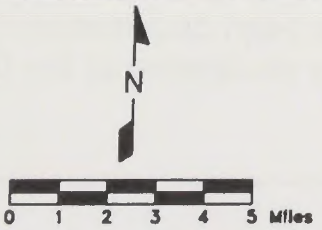

**300' Contour Interval**

Source for Fault Traces: Dohrenwend et al. 1995
Source for Seismic Events: National Earthquake Information Center Data Base

Legend

| | |
|---|---|
| ━ | Holocene to Late Pleistocene Faults |
| ─ | Undifferentiated and Undated Faults |
| ▨ | Seismic Event Pre-1970 Magnitude 4.0 -4.9 |
| ● | Seismic Event Post-1970 Magnitude 4.0 -4.9 |

Figure 3.1-6

Quaternary Faults and Seismic Events

4.0 to 4.9 (U.S. Geological Survey [USGS] Earthquake Database).

## 3.1.2 Environmental Consequences

Environmental issues related to geology and minerals include: (1) the potential for karst development from ground water infiltration and injection, (2) potential surface subsidence caused by cavern collapse (sinkholes) from ground water discharge, (3) the potential for minerals todissolve and metals to be released as a result of dewatering and water management operations, and (4) dewatering-induced surface subsidence

### 3.1.2.1 Impacts from Mine Dewatering and Localized Water Management Activities

#### Karst Development and Other Solution Features

Karst refers to solution features that occur in some areas underlain by limestone or carbonate rocks. Karst-type features include solution cavities and sinkholes that form with the dissolution of calcium carbonate. Areas affected by dissolution processes can experience occasional rapid (localized) subsidence where the solution cavities are located near the surface. The solution process may be accelerated by man-made changes in ground water conditions, including: (1) discharging excessive water into geologic materials susceptible to karst development and (2) lowering the water table, which can both increase vertical seepage rates and cause collapse of near-surface caverns that were buoyed by the water table.

Most younger sinkholes are caused by a collapse process. The development of sinkholes can pose a hazard to livestock, humans, and wildlife. If the sinkhole develops in the area of buildings, roads, and other structures, damage to these structures may result.

Accelerated sinkhole development caused by mine dewatering has been documented worldwide (Brink 1984; Kath et al. 1995; Wagner and Day 1984). One well-documented sinkhole problem caused by mine dewatering occurs in the dolomites of South Africa. The dolomites are above the gold-bearing conglomerates that were dewatered to enable mining. Hundreds of sinkholes have developed since the 1960s; several of these sinkholes have been very large causing loss of life and damage to buildings and other structures (Brink 1984; Wagner and Day 1984). Additional sinkhole development has occurred from dewatering of limestone quarries in the southeastern United States (Kath et al. 1995).

Several different processes can cause sinkhole or doline development. A doline is a basin or funnel-shaped hollow in limestone and does not imply a specific genesis. The processes that cause dolines are shown schematically in Figure 3.1-7 (Ogden 1984). The top two block diagrams in Figure 3.1-7 show dolines that occur when carbonate rocks are at the ground surface or are covered by a thin layer of soil. These dolines form either by collapse of an underground cavity near the ground surface (collapse doline) or slow preferential dissolution of rock along fractures (solution doline). The bottom two block diagrams depict limestone covered by soil or loosely consolidated rock material. These dolines form either by gradual subsidence caused by vertical erosion or piping of the cover material into subterranean voids (subsidence dolines) or collapse of the overlying material into underlying cavities (subjacent karst collapse dolines).

**Karst Development in the Region**. In the carbonate province of Nevada, caves and caverns have been documented in the limestone (Hess 1992). The only known caves or caverns identified in the cumulative study area occur in the carbonate rocks encountered in Barrick's Meikle Mine (part of the Goldstrike Project). The cavities encountered in the Meikle Mine range up to an estimated 100 to 150 feet wide, 30 to 50 feet high, and several hundreds of feet long. In the Meikle Mine, these caverns are characterized by having a massive rind of coarse calcite and barite crystals up to several feet thick. To-date, none of the cavities encountered during mining have shown evidence of collapse during dewatering or present any stability concerns for the mining operations.

Two sinkholes have been documented to-date in the area affected by dewatering at the Goldstrike

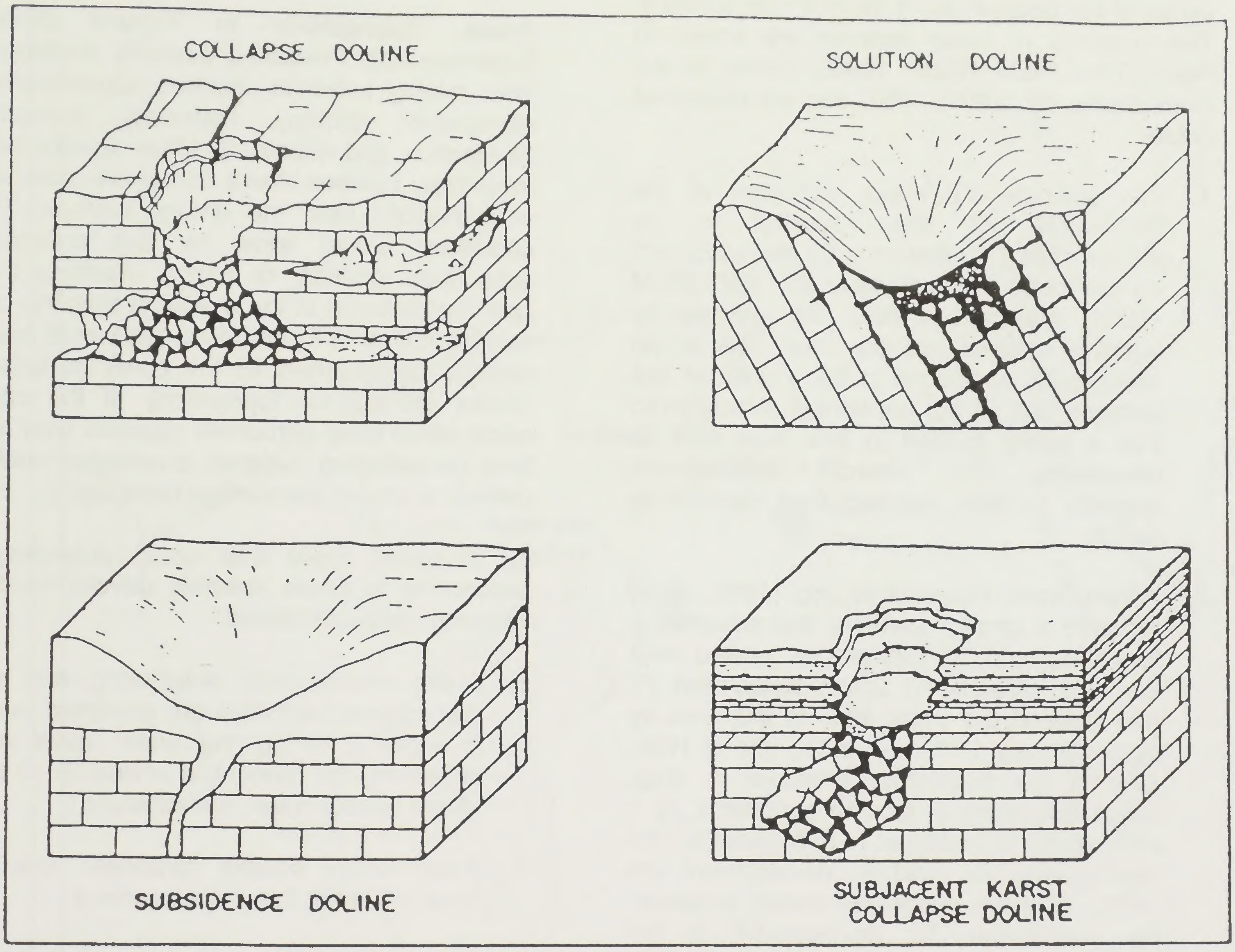

Figure 3.1-7

Block Diagrams of Sinkhole Development

Mine: (1) a sinkhole approximately 3.5 miles northwest of the center of the Betze-Post Pit, and (2) a sinkhole approximately 2.8 miles west of the center of the Betze-Post Pit located near spring 6. The locations of these features are shown in Figure 3.1-8 (BLM 1998b, 1993c; Adrian Brown Consultants, Inc. 1997, 1998) and are described below.

1. The sinkhole 3.5 miles northwest of the Betze-Post Pit was reported to be approximately 80 feet long, 60 feet wide, and 40 feet deep on September 29, 1993 (BLM 1993c). Barrick has filled the sinkhole by pushing material into the hole. The actual site-specific conditions in the vicinity of this collapse feature are not known. It is inferred that a cavity existed in this area prior to dewatering. The sinkhole development appears to have resulted from dewatering activity.

2. Adrian Brown Consultants, Inc. (1997, 1998) reported a circular sinkhole approximately 4 feet deep and 30 feet across located near spring 6. Dewatering of the Betze-Post Pit had lowered the water table in this area by approximately 1,100 feet at the end of 1996, causing the hydrostatic pressure to drop. Since this spring is located approximately 1 mile south of sinkhole 1, it is possible the mechanisms for sinkhole development are similar to those suggested above; however, the mechanism for development is not known.

**TS Ranch Reservoir Fracture**. An open fracture was discovered in the bottom of the south-central portion of TS Ranch Reservoir in the summer of 1990. The general location of this feature is shown in Figure 3.1-8. This fracture can be traced on the surface for several hundred feet south of the reservoir. The fracture occurs in Tertiary Rhyolite and is open, with the width of the void space along the fracture ranging up to several inches. This fracture presumably existed prior to reservoir development; however, piping and/or dissolution of the fracture-filling material occurred after the reservoir was used to store water. Initially, a fraction of the water stored in the reservoir flowed out of the reservoir through the fracture. In the last several years, a series of dikes have been constructed in the reservoir to isolate and control flow out of the reservoir through the fracture.

**Areas Susceptible to Future Sinkhole Development**. Predicting sinkhole development from mining activities requires consideration of site-specific geology, hydrology, topographic information, and climate. Sinkhole development is most likely in areas where carbonate rocks are at or sufficiently near the ground surface. These conditions would allow for the collapse of subsurface cavities, or piping (washing out of granular material) of the overlying soils into those cavities. Either of these processes would result in enough displacement of the cover materials to impact the surface topography. If the cavities occur within deep carbonate deposits overlain by thick consolidated material, a collapse would be unlikely to impact the surface topography.

To delineate areas that could potentially be susceptible to future sinkhole development, the following were considered:

1. Areas where mine dewatering and water management activities are predicted to result in either lowering the water table and/or increasing the amount of infiltration (in areas where excess water is discharged).

2. Areas where soluble carbonate rock units exist at or near the ground surface

3. The depth to the carbonate rock below the ground surface

Several scenarios of soil cover, depth to ground water, and carbonate rock depth were evaluated to develop criteria for use in identifying areas that could potentially be susceptible to sinkhole (or doline) development. For the purpose of this evaluation, it was assumed that the dimensions of the largest cavity that could potentially be encountered in the subsurface was 150 feet in width and approximately 50 feet high (based on observations in the Meikle Mine). These dimensions were used to predict the maximum thickness of the overburden material (soil or rock) required to completely contain any stoping or dome fallouts that could occur without breaking through to the ground surface.

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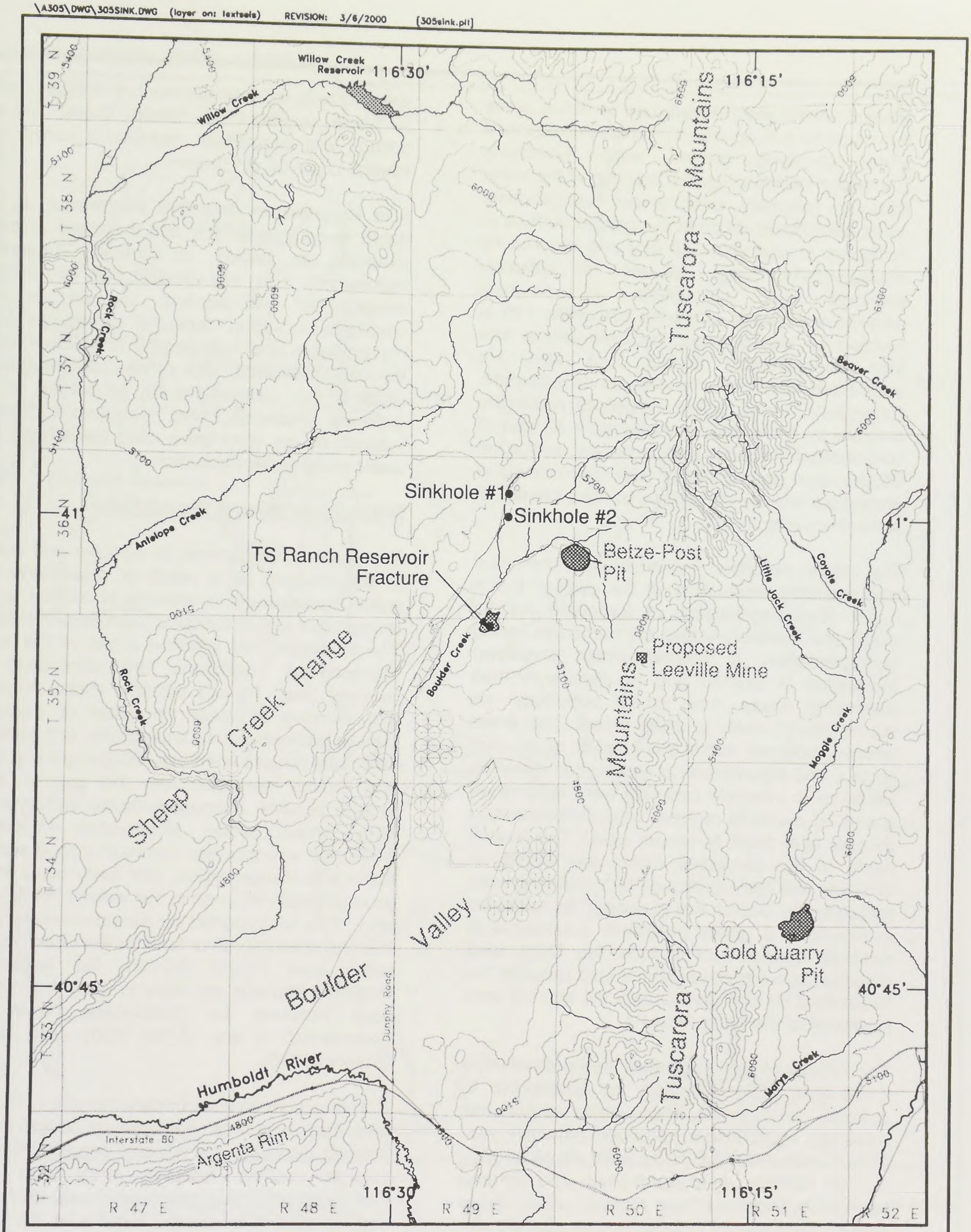


Legend

○ Center Pivot Irrigation

Figure 3.1-8

Solution and Fracture Features Identified as of December 1998

Several criteria were established to define areas that could be susceptible to sinkhole development under changing ground water conditions (increased infiltration and/or lowering of the water table). In summary, areas where the carbonate rocks are located either at the ground surface or at depths of less than 250 feet and covered by unconsolidated (e.g., alluvial or colluvial) materials are susceptible to sinkhole development. Areas where the carbonate rock is overlain by consolidated, insoluble layers less than approximately 50 feet thick also are considered susceptible to sinkhole development. Conversely, areas where carbonate rocks are overlain by more than approximately 50 feet of consolidated, insoluble rock materials, and/or are deeper than approximately 250 feet below the ground surface are considered to have low risk of sinkhole development.

The criteria described previously were combined with available information on the geology in the region (including location of carbonate outcrop areas and materials above the carbonate rocks) and prediction of ground water drawdown (presented in Section 3.2) to develop a map illustrating areas that could potentially be susceptible to sinkhole development. The areas where carbonate rocks are located at or near surface and assumptions of overburden materials (alluvium or insoluble bedrock) were determined based on available regional geologic information (Maurer et al. 1996; Newmont 1998). The general depth to the carbonate rocks was based on available well completion logs for monitoring wells completed by Barrick and Newmont. As illustrated in Figure 3.1-9, areas potentially susceptible to sinkhole development include the large area underlain by carbonate rock located between the Betze-Post Pit and Gold Quarry Pit, and the area northwest of the Betze-Post Pit.

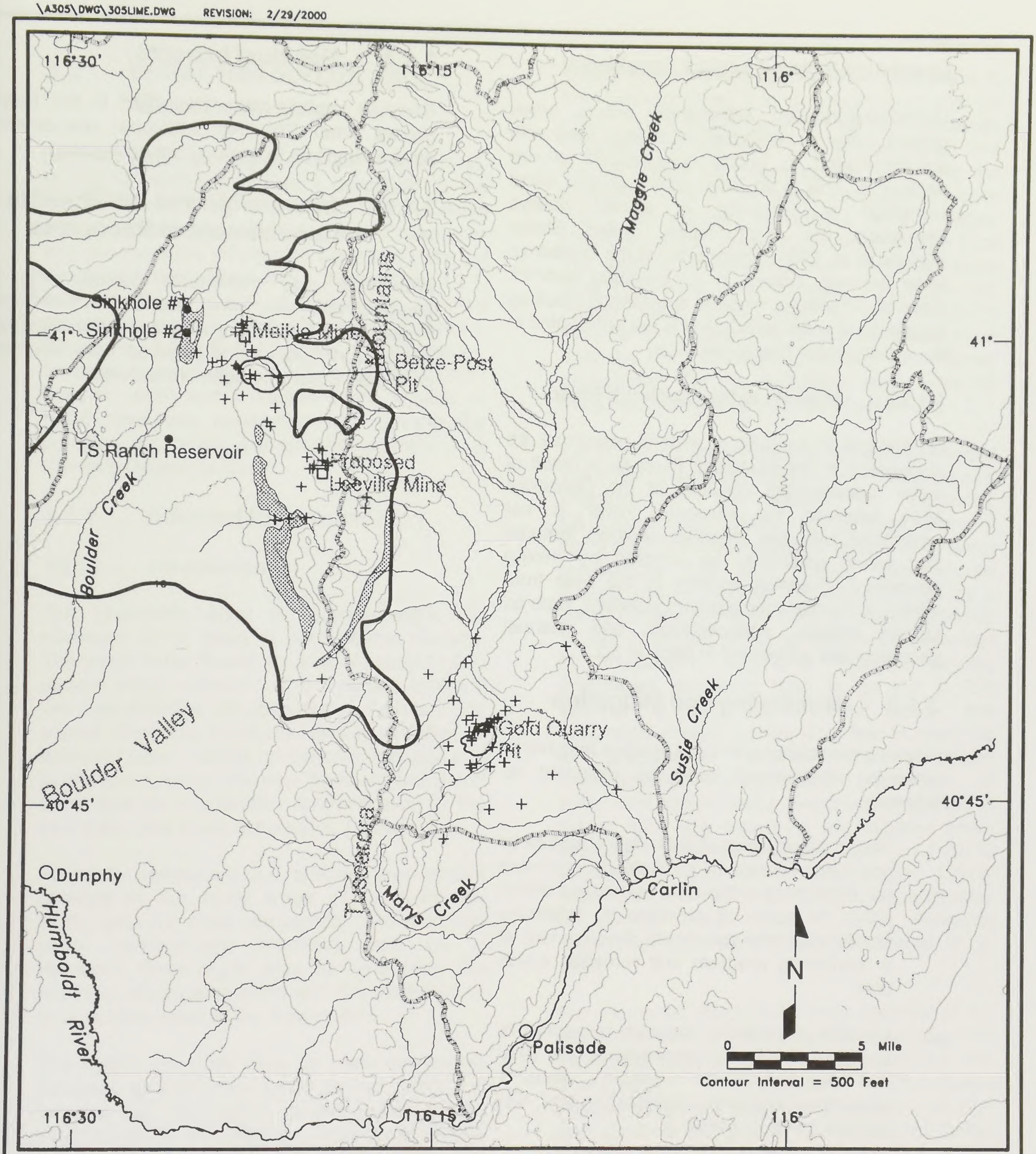
The results of this evaluation delineate several areas that could potentially be susceptible to sinkhole development. These areas contain few buildings, major roads, or other infrastructures. Critical mine-related facilities such as waste rock storage facilities, heap leach pads, and mill and tailings facilities are not located within these areas. A segment of a power line associated with the Carlin Mine occurs within an areas that could be susceptible to karst development. Other non-mine-related features of note located within these areas include a 1-mile segment of Boulder Creek, a 1-mile segment of Sheep Creek, several springs and intermittent streams, a corral, and several unpaved dirt roads.

It is important to note that information on the depth to carbonate rock and thickness of cover materials is based on limited subsurface information. The site-specific risk of sinkhole development will depend, in part, on site conditions including depth to carbonate rocks, mineralogical and hydrological characteristics of the carbonate rock, size of new or pre-existing voids in the carbonate rock, properties of the overlying materials, and hydrologic changes induced by the cumulative mine dewatering and water management activities.

### Potential for Mineral Dissolution

The potential for minerals to dissolve and metals to be released as a result of dewatering and water management operations is related to the temperature and chemical properties of the water. The infiltration and injection areas of the water management operations are dominated by younger basin fill and volcanic rocks. Minerals that dissolve in water (in order of solubility) include halite, gypsum, and calcite; and minerals that could release elements into the ground water and absorb elements from the ground water include zeolites. Evaporites (halite and gypsum) form when water evaporates. Localized evaporate deposits are common throughout the Basin and Range region, and likely occur in the younger basin fill found in the valleys of the study area. This is supported by considerable variation in water chemistry over time for the Green Spring water (see Figure 3.2-32). No large-scale evaporite deposits are likely to exist in the study area because no Pleistocene lakes are documented in any of the study area valleys (Stewart 1980).

Calcite occurs as a secondary mineral in alluvium and may occur as fracture/vug fillings in the volcanic deposits. The volcanic deposits may also contain zeolites that fill voids and vugs. Continued infiltration and injection activities would likely result in local mineral dissolution. Impacts to water quality associated with infiltration and injection are addressed in Section 3.2.2.2.



Legend

| | |
|---|---|
| ▨ | Ground Water Basin Boundary |
| — | Stream |
| ━ | Maximum Drawdown Area (≥10 Feet of Drawdown) |
| + | Well Used to Define Depth to Limestone |
| ▨ | Areas that Could Potentially be Susceptible to Sinkhole Development |
| ☐ | Areas Unlikely to be Impacted by Sinkhole Development |

Figure 3.1-9

Areas Potentially Susceptible to Sinkhole Development

Dewatering-induced Surface Subsidence

Dewatering-induced subsidence occurs when ground water is withdrawn in valleys filled with unconsolidated to poorly consolidated alluvial sediments. This is an issue where ground water extraction is occurring in alluvial valleys throughout the southwestern United States (Poland et al. 1984). Dewatering at the Goldstrike Mine primarily occurs in consolidated bedrock material. Therefore, regional subsidence resulting from ground water withdrawal is not anticipated in the vicinity of the Goldstrike Mine.

#### 3.1.2.2 Impacts to the Humboldt River

No impacts to geologic or mineral resources are anticipated to the Humboldt River as a result of water management activities at the Goldstrike Mine because the Humboldt River is not associated with any identified geologic features that would potentially be affected by mining operations. Potential impacts to the river from mining and water management activities, such as stream erosion, sedimentation, and channel geometry, are addressed in Section 3.2.2.2.

### 3.1.3 Monitoring and Mitigation

Hazards associated with karst solution features or sinkhole development could be mitigated as follows:

1. Report any suspected subsidence feature or possible evidence of sinkhole development (on BLM land) to the BLM authorized officer within 24 hours of detection to determine significance and coordinate development of a monitoring program and remedial action plan.
2. Develop site-specific remedial measures or a mitigation plan for approval by the BLM that may include, as necessary, plans to arrest the subsidence, stabilize the land, and restore surface conditions.
3. Implement approved remedial measures or mitigation plan.

### 3.1.4 Residual Impacts

Residual impacts were described in the Betze Project Final EIS. No additional unavoidable adverse impacts to geology are anticipated.

### 3.1.5 Irreversible and Irretrievable Commitment of Resources

Irreversible and irretrievable commitments of geologic resources were described in the Betze Project Final EIS. No irreversible or irretrievable geologic impacts are anticipated from Barrick's continued water management activities.

## 3.2 Water Resources and Geochemistry

Baseline water quantity and quality in the vicinity of the Goldstrike Mine were described in the Betze Project Draft EIS (BLM 1991a). Since 1991, considerable additional water resources and geochemistry information has been collected throughout the project area. Subsection 3.2.1, Affected Environment, includes an updated description of the premining conditions. Subsection 3.2.2, Environmental Consequences, provides an evaluation of impacts to date (1991 through 1998) and projected future impacts to water resources associated with groundwater pumping and water management operations at Barrick's Goldstrike Mine.

### 3.2.1 Affected Environment

#### 3.2.1.1 Introduction

The Goldstrike Mine is located within the Humboldt River basin in north-central Nevada. The entire basin covers an area of nearly 17,000 square miles; upstream of the project facilities, the river drainage occupies approximately 7,500 square miles. The Humboldt River flows within an enclosed basin, having no external drainage to a larger flow system. The river flows westward and terminates by evaporation and infiltration in the Humboldt Sink south of Lovelock, Nevada.

For water resources, the affected environment consists of two study areas: (1) a hydrologic study area for mine dewatering (and localized water management activities), and (2) a Humboldt River study area for evaluating the potential effects associated with the discharge of excess mine water to the river system.

The hydrologic study area for mine dewatering occupies approximately 2,060 square miles and includes six designated ground water basins established by the Nevada Division of Water Resources (Figure 3.2-1) (Riverside Technology, inc. [RTi] 1994; McDonald Morrissey Associates, Inc. 1998; AATA International, Inc. 1998a, 1997; Nevada Division of Wildlife 1998b, 1996b, 1978; Valdez et al. 1994). These ground water basins, their state identification numbers, and their land surface areas are listed in Table 3.2-1. These ground water basins drain southward to the Humboldt River. The hydrologic study area for mine dewatering is bounded by the Tuscarora Mountains on the north, the Adobe Range and Independence Mountains on the east, and the Humboldt River on the south. As shown in Figure 3.2-1, the western boundaries of the Willow Creek and Rock Creek ground water basins form the western boundary of the hydrologic study area. Elevations within the study area range from approximately 8,800 feet in the Tuscarora Mountains to 4,500 feet on the Humboldt River near the town of Battle Mountain. The affected environment for the hydrologic study area for mine dewatering is described in Section 3.2.1.2.

For this study, the streams have been subdivided into three types of reaches that define the general character of the reach: (1) perennial, (2) discontinuous flowing, or (3) intermittent or ephemeral. Perennial stream reaches have some measurable flow year round. Discontinuous flowing stream reaches are characterized as a series of generally short (tens of feet to hundreds of feet in length) perennial segments separated by intermittent segments (defined below). Intermittent segments tend to go dry in late summer to early fall in most years, and ephemeral stream reaches only flow in response to precipitation events. The perennial, discontinuous flowing, and intermittent or ephemeral stream reach segments presented in Figure 3.2-1 are based on the baseline water resource information presented in AATA International, Inc. 1997, 1998a; JBR 1990a; Newmont Gold 1991, 1992a, b; Nevada Division of Wildlife 1978, 1996b, 1998b; Riverside Technology, inc. (RTi) 1994; and Valdez et al. 1994.

The Humboldt River study area consists of the Humboldt River and its floodplain, extending from the USGS gage at Carlin to the Humboldt Sink downstream of Lovelock. Quantitative assessments have been conducted for the river from Carlin to the gage at Comus, approximately 9 miles east of Golconda (Figure 1-6). Semi-quantitative or qualitative assessments have been conducted from Comus to the sink. This approach was used because of the locations of mining discharge, the availability of data, and the increasing influence of irrigation practices and evapotranspiration losses in the downstream

### Table 3.2-1
### Major Subregions Within the Hydrologic Study Area

| Nevada Designated Ground Water Basin | Basin Number | Approximate Land Area (square miles) |
|---|---|---|
| Susie Creek | 50 | 220 |
| Maggie Creek | 51 | 410 |
| Marys Creek | 52 | 60 |
| Boulder Flat | 61 | 560 |
| Rock Creek Valley | 62 | 450 |
| Willow Creek Valley | 63 | 420 |

Source: Nevada State Engineer's Office 1992; Maurer et al. 1996.

direction. The affected environment for the Humboldt River Study Area is described in Section 3.2.1.3.

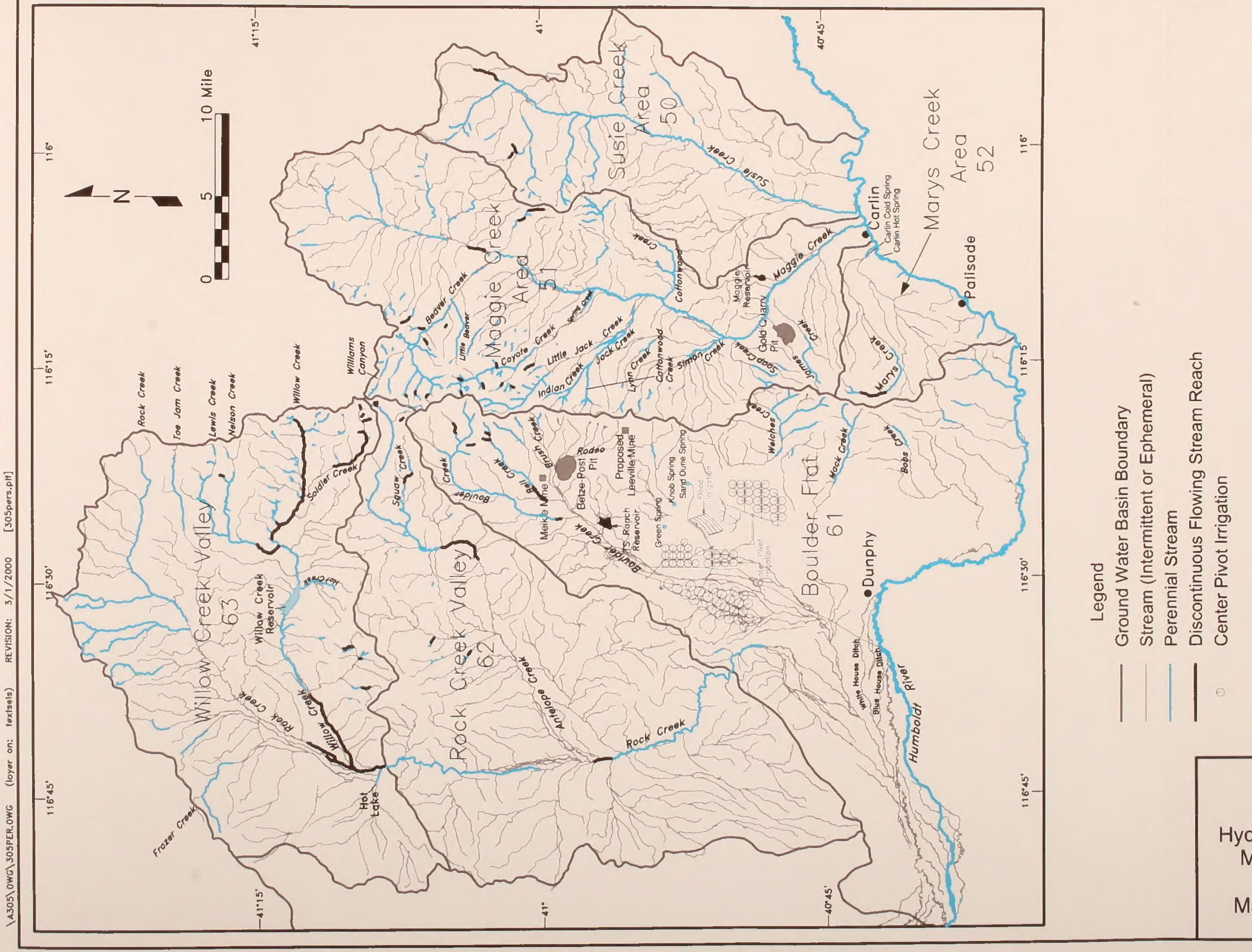
## Hydrometeorology

Average annual precipitation varies widely within the region but generally increases with elevation (Figure 3.2-2) (Plume 1995). Most precipitation falls as snow in the mountains as a result of frontal storms between November and May. Total annual precipitation ranges from 5 to 8 inches on Boulder Flat and 15 to 20 inches at higher elevations in the Tuscarora Mountains. The mean annual snowfall is over 40 inches at places in the Tuscarora Mountains (McDonald Morrissey Associates, Inc. 1996b). Average monthly precipitation values for approximately 50 years of record at Elko and Battle Mountain are shown in Figure 3.2-3 (Earthinfo Inc. 1997; National Climatic Data Center 1999). Total annual precipitation has averaged 9.6 inches at Elko and 7.7 inches at Battle Mountain over this period (Figure 3.2-4) (RTi 1998). Precipitation varies along the river, but generally decreases toward the Humboldt Sink. Average annual precipitation is 8.2 inches at Winnemucca and 5.2 inches at Lovelock (National Oceanic and Atmospheric Administration - Cooperative Institute for Environmental Sciences 1999).

The variation in mean annual precipitation for periods of interest to the surface hydrology analysis is compared to the longer historical record (1944 through 1998) in Table 3.2-2. A regional drought affected the area between 1985 and 1993 and is most noticeable in the Elko data shown below. Corresponding to this period of less precipitation at higher elevations, the total flow in the Humboldt River at the Carlin gage in 1987 was approximately 40 percent of normal; in 1992, the total flow at the same site was approximately 20 percent of normal (Maurer et al. 1996). In addition to flow effects from less precipitation in the headwaters, irrigation demands during those dryer years reduced flows in the river. Normal or above normal precipitation rates occurred in most areas of Nevada after 1993 (RTi 1998).

High streamflows may occur in the winter or early spring as a result of rain on snow or frozen ground, but more commonly the annual high flow events occur from snowmelt in the spring. Snowmelt and winter frontal storms can result in sizable runoff volumes and high flood stages over large areas, particularly from rain-on-snow events. Occasionally, isolated flooding may result from intense local thunderstorms, which most often occur from late spring through the fall. These events produce the most intense precipitation in the region, but they are typically limited in duration and extent. As a result, flash floods from thunderstorms generally have larger peak flows than snowmelt events, but they are typically confined to smaller areas and shorter timeframes.

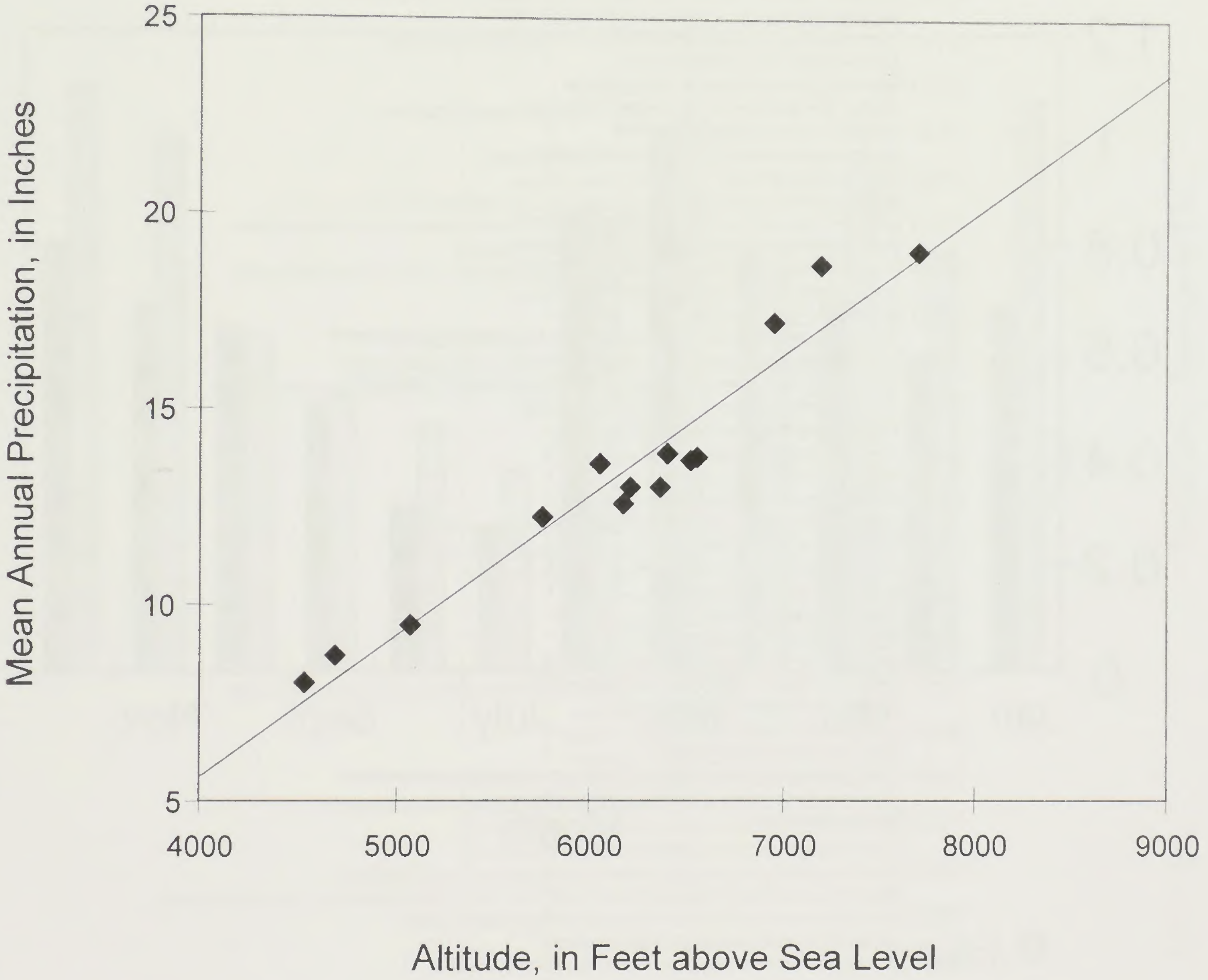
Evaporation, as measured from Class A pan devices, averages about 60 inches per year in the hydrologic study area (National Oceanic and Atmospheric Administration 1982). After accounting for pan characteristics, this converts to a free water surface evaporation rate of about 44 inches per year. This rate approximates the



Note: Stream locations are taken from USGS line graph database. Hydrographic Area Boundary locations are approximate.

Figure 3.2-1

Hydrologic Study Area for Mine Dewatering and Localized Water Management Activities



Source: Plume 1995

Figure 3.2-2

Relation of Mean Annual Precipitation to Altitude

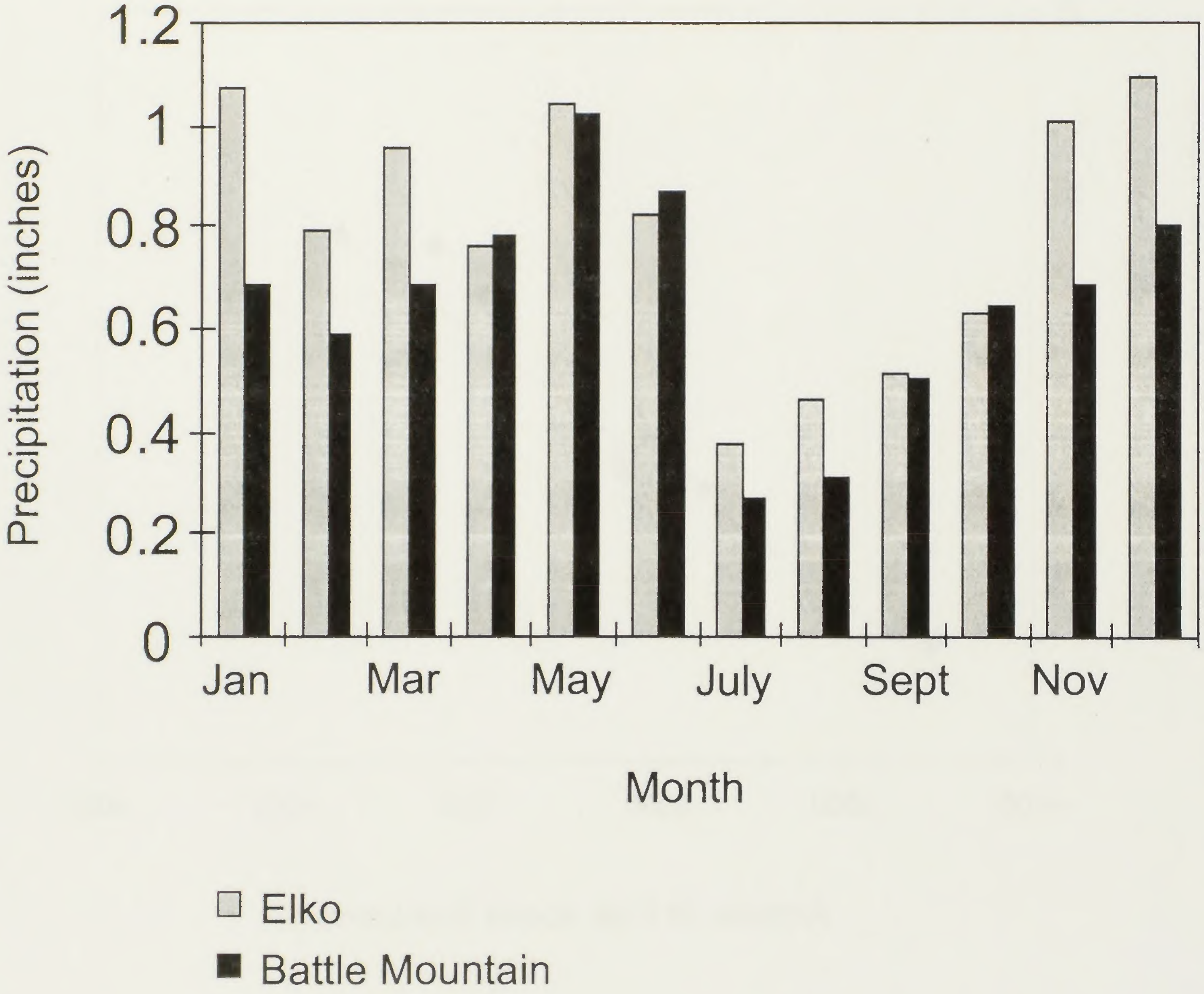


Figure 3.2-3

Average Monthly Precipitation at Elko and Battle Mountain

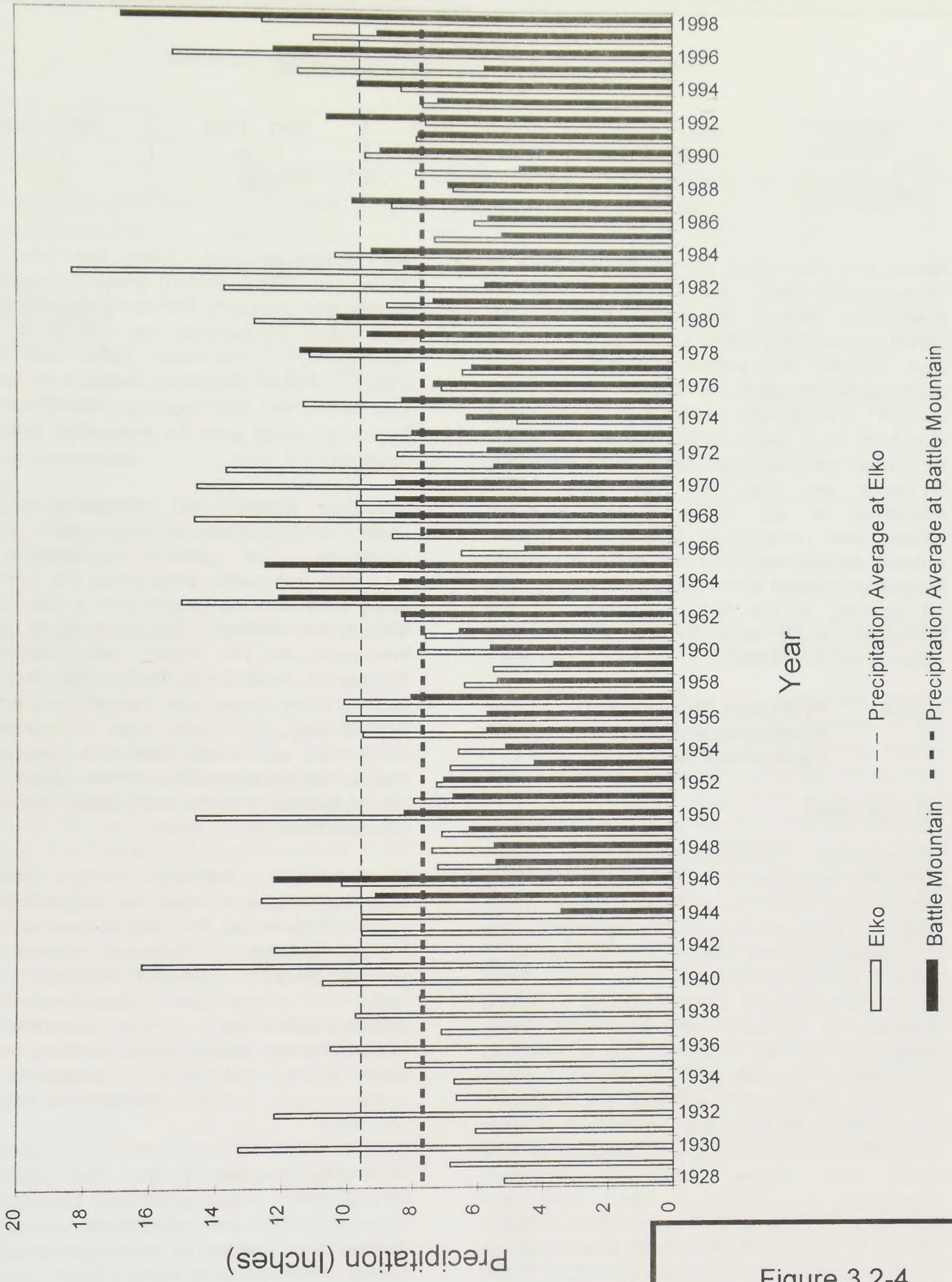


Figure 3.2-4

Annual Precipitation at
Elko and Battle Mountain

Table 3.2-2
Mean Annual Precipitation (inches)

| Station | 1944 - 1998 | 1981 - 1990 | 1991 - 1998 | 1985 - 1993 |
|---|---|---|---|---|
| Elko | 9.57 | 9.72 | 10.20 | 7.68 |
| Battle Mountain | 7.68 | 7.46 | 9.88 | 8.01 |

losses that may occur from a shallow lake or slow-moving river. Barrick has collected evaporation data at the Goldstrike Mine from spring to fall since 1990. These partial records also indicate an annual average for pan evaporation of about 60 inches. Free water surface evaporation estimates within the Humboldt River basin range from approximately 42 inches per year near Elko to approximately 54 inches per year near the Carson Sink (Houghton et. al., 1975). Evapotranspiration losses vary because of differences in plant species requirements and soil moisture storage. Evapotranspiration is estimated to consume up to 90 percent of the total precipitation in the hydrologic study area (McDonald Morrissey Associates, Inc. 1996b).

### 3.2.1.2 Hydrologic Study Area for Dewatering and Localized Water Management Activities

Ground Water

Hydrogeologic investigations have been performed to provide information on the existing ground water conditions of the study area. These include hydrogeologic investigations that (1) evaluate potential effects of mine dewatering (Adrian Brown Consultants, Inc. 1991, 1992; Balleau Groundwater Consulting and Leggette, Brashears & Graham, Inc. 1992; BLM 1991a; Leggette, Brashears & Graham, Inc. and Balleau Groundwater Consulting 1993; Barrick 1999a; Newmont 1997c; (2) summarize the effects of ground water use along the Carlin Trend (Maurer et al. 1996); (3) present a conceptual ground water flow model (McDonald Morrissey Associates, Inc. 1996a, b, 1997, 1998; and Hydrologic Consultants, Inc. 1997b, 1998a, 1999a); (4) summarize the effects of water use on the Humboldt River (RTi 1998; JBR 1996b, 1997; Hydrologic Consultants, Inc. 1997a); (5) report on the impacts of Gold Quarry Mine dewatering (Newmont 1992a); and (6) quantify ground water quality and chemistry (Radian International, LLC and Baker Consultants, Inc. 1997a, b; Water Management Consultants 1994; and Cohen 1962). These investigations describe the baseline information and hydrogeologic conditions of the hydrologic study area for evaluating dewatering impacts.

Recharge, storage, and movement of ground water is dependent in part upon geologic conditions. The general stratigraphic and structural framework throughout the hydrologic study area and the project site is described in Section 3.1, Geology. The generalized geologic conditions in the region are illustrated in Figures 3.1-1 and 3.1-2. The geologic formations in the study area can be grouped into six hydrostratigraphic units, as described in Section 3.1, and include (from oldest to youngest) marine carbonate rocks, marine clastic rocks, intrusive rocks, volcanic rocks, older basin fill, and younger basin fill.

In bedrock, the recharge, storage, flow, and discharge of ground water are largely controlled by the structure (i.e., fault and fracture zones, and solution cavities in carbonate rocks) of the geologic material. In the basin fill alluvium, ground water is stored and transmitted through interconnected pores within consolidated to unconsolidated sediments. In the study area, the main aquifers are found in carbonate rocks, volcanic rocks, and basin-fill deposits (Maurer et al. 1996)

**Hydrostratigraphic Units.** The six hydrostratigraphic units and their hydrogeologic characteristics are discussed below. The hydraulic parameters for each hydrostratigraphic unit are summarized in Table 3.2-3.

Table 3.2-3
Summary of Hydrostratigraphic Unit Hydraulic Properties

| Hydrostratigraphic Unit | Pumping Rate (gpm) | Estimated Hydraulic Conductivity (feet/day) | Estimated Transmissivity (feet$^2$/day) | Estimated Storage Coefficient (no units) |
|---|---|---|---|---|
| **Younger Basin Fill** | Up to 3,600 in Boulder Valley[2] | 1 to 100[2] | 4,500[1] - 13,400[2] | 0.0025[1] |
| **Older Basin Fill** | <100 - 1,000[1] | 0.05 - 5[2] | 20 - 900[2] | 0.0038[2] |
| **Intrusive Rocks** | Generally <10[2] | 0.01 - 1 | NA | NA |
| **Volcanic Rocks** | Up to 5,800 in Boulder Valley[2] | 0.5 - 250[2] | 300 - 100,000[2] | 0.0007 - 0.003[2] |
| **Marine Clastic Rocks** | 10 - 1,000[2] | 0.0014 - 100[1] | 30 - 800[2] | 0.0001 - 0.004[2] |
| **Marine Carbonate Rocks** | 330 - 4,100[2] | 0.1 - 400[2] | 13 - 300,000[2] | 0.0002 - 0.014[1] |

[1] Maurer et al. 1996.
[2] McDonald Morrissey Associates, Inc. 1996a, b, 1998.
NA - No data available.

Marine Carbonate Rocks. The Paleozoic marine carbonate rocks consist of limestone and dolomite and lesser amounts of shale, sandstone, and quartzite. These rocks are mainly Cambrian to Devonian in age but locally also include Pennsylvanian/Permian carbonate rocks. The western edge of the carbonate rock province is located approximately 6 miles northwest of the Betze-Post Pit. Carbonate rocks appear at the surface in the Tuscarora Mountains south of the Betze-Post Pit and in bedrock outcrops in the Maggie Creek and Susie Creek basins (Figure 3.1-2). Carbonate rocks are believed to underlie the younger units and the marine clastic rocks (beneath the Roberts Mountain Thrust) in areas within the carbonate rock province. In areas of carbonate rock outcrop, the overlying clastic rocks and younger volcanics are thought to have been removed by erosion (McDonald Morrissey Associates, Inc. 1996b).

The marine carbonate rocks have low primary permeability. The bulk hydraulic conductivity for most materials reportedly ranges from 0.2 to 10 feet per day (Maurer et al. 1996). However, where they are faulted or fractured coupled with dissolution, their transmissive properties greatly increase. For example, within the Meikle Mine, caverns with widths greater than 100 feet have been discovered in the carbonate rocks.

Marine Clastic Rocks. The Paleozoic marine clastic rocks consist of interbedded shale, siltstone, chert, quartzite, and limestone. Marine clastic rocks are believed to underlie the alluvium and volcanic rocks in most of the study area, and they form the upper plate of the Roberts Mountain Thrust. They have been mapped mainly as Vinini Formation in the study area. These clastic rocks are exposed in the Tuscarora Mountains, Independence Range, and Adobe Range (Figure 3.1-2). They have been extensively thrusted and eroded, and estimates of their thickness range from 50 to 5,000 feet. These rocks are fine-grained and have low hydraulic conductivity with most reported values ranging from 0.01 to 0.5 foot per day (McDonald Morrissey Associates, Inc. 1996b), but local faulting, fracturing, and solution widening can increase secondary permeability (Maurer et al. 1996).

Intrusive Rocks. Tertiary through Jurassic intrusive rocks are a minor component of the rock types in the study area (Figure 3.1-2) and consist mostly of granodiorite, quartz monzonite, monzonite, and diorite. The intrusive rocks form a relatively impermeable boundary immediately south of the Betze-Post Pit. They also mark the southern boundary of mineralization in the mine area. Reasonable estimates of hydraulic conductivity are 0.01 to 1 foot per day, and wells generally yield less than 10 gallons per minute (gpm) (McDonald Morrissey Associates, Inc. 1996b). Wells completed in the intrusive rocks may yield small quantities of water near some faults (Maurer et al. 1996).

Volcanic Rocks. Tertiary through Jurassic volcanic rocks consist of a wide range of igneous rock types: rhyolitic to basaltic lava flows, welded and nonwelded ash-fall tuffs, flow breccia, and tuffaceous sedimentary rocks. The volcanics occur throughout the area with most of the exposures in the western, northern, and south-central portions of the hydrologic study area (Figure 3.1-2). This wide range of rock types results in highly variable hydraulic parameters. The welded tuff, basalt, and andesite generally have low transmissive properties, while the rhyolite, particularly where fractured, is more transmissive. Overall, the hydraulic conductivity of volcanic rocks in the area is probably between 0.5 and 200 feet per day (McDonald Morrissey Associates, Inc. 1996b). In the northern margin of Boulder Valley the rhyolite is highly fractured, and its hydraulic conductivity could approach 250 feet per day.

Older Basin-fill Deposits. Pliocene to Miocene age basin-fill deposits in the area are primarily composed of poorly consolidated shale, claystone, mudstone, siltstone, sandstone, conglomerate, freshwater limestone, tuff and lava flow (Plume 1995; Maurer et al. 1996). These deposits accumulated in basins that developed in the earliest stages of extensional faulting. In the upper Maggie Creek basin, these deposits are estimated to be up to 6,000 feet thick. In Susie Creek and lower Maggie Creek basins, the deposits are generally less than 2,000 feet thick (HCI 1999b). Wells completed in the Carlin Formation have reported yields ranging from less than 100 to 1,000 gpm. In the Maggie Creek area, hydraulic conductivity ranges from 1 to 7 feet/day and transmissivity from 780 to 9,800 square feet/day (Maurer et al. 1996). In the northern part of Boulder Flat, transmissivity is estimated to range from 70 to 300 square feet/day (Stone et al. 1991). Locally, the fine-grained beds act as an aquitard producing confined ground water conditions in the underlying rocks (BLM 1991a).

Younger Basin-fill Deposits. The Quaternary alluvium contains a wide range of materials: sandy clay, silty sand, gravelly sand, and sandy gravel. The thickness and lateral extent of this material is also highly variable. In higher elevation mountain areas, the alluvium occurs as discontinuous to continuous strands of unconsolidated material covering or partially covering bedrock along the floor of the valley or ravine. Alluvium in higher elevation areas is generally less than a few tens of feet thick. In broad basin areas, such as Boulder Flat, and to a lesser extent in the Maggie Creek and Susie Creek basins, the alluvium occurs as sequences of unconsolidated to poorly consolidated material up to 1,000 feet thick (McDonald Morrissey Associates, Inc. 1996b). Overall, the alluvium is generally coarser-grained in the mountains and finer-grained in the basins, and it becomes finer toward the center of the basin. The alluvium also is characterized by significant lateral and vertical stratigraphic variation with clay typically occurring as thinly bedded lenses. The alluvium is generally presumed to be an unconfined aquifer; however, semi-confined conditions may exist locally where less permeable fine-grained units inhibit vertical flow. Values of hydraulic conductivity are estimated to range from 1 to 100 feet per day (McDonald Morrissey Associates, Inc. 1996b).

**Hydrostructural Units.** Ground water flow pathways are influenced by major faults that offset and displace rock units and older alluvial deposits. Depending on the physical properties of the rocks involved, faulting may either result in the fault zone behaving as an impediment or conduit for ground water flow relative to the surrounding hydrostratigraphic units. For example, faulting of softer, less competent rocks typically forms zones of crushed and pulverized rock material that tend to impede or reduce ground water movement across the fault zone. In addition, faulting may impede flow by juxtaposing rocks with low relative permeabilities against rocks with much higher permeabilities. In contrast, faulting of hard, competent rocks often creates conduits along the fault trace resulting in zones of higher ground water flow and storage capacity compared to the unfaulted surrounding rock. Depending on the rock materials and style of fault movement, it is possible for the fault to act as both an impediment to flow across the fault and a conduit to flow along the strike of the fault.

Long-term monitoring of drawdown and mounding in the vicinity of the Goldstrike property has resulted in the recognition of three major faults or fault zones that tend to impede the movement of ground water across the faults. These faults include the (1) Boulder Narrows Fault located in Boulder Valley; (2) Siphon Fault located between the TS Ranch Reservoir and the Betze-Post Pit; and (3) Post Fault located on the east side of the Betze-Post Pit. The locations of the major hydrostructural features are illustrated in Figure 3.2-5 (McDonald Morrissey Associated 1998), and a generalized cross-section is shown in Figure 3.2-6 (Barrick 1999a).

Boulder Narrows Fault. The Boulder Narrows Fault in Boulder Valley has no surface expression. McDonald Morrissey Associates, Inc. (1997) reports that evidence for this fault includes: (1) offset of rhyolite in the area of the fault by approximately 700 feet; (2) the presence of Green, Knob, and Sand Dune springs (see the section on Seeps and Springs below for a description of these springs); (3) Newmont gravity surveys indicating that the basin is 3,000 feet deep just to the south of the fault; and (4) water-table gradients in the alluvium that are noticeably steeper, and water levels appear to be elevated north of the fault. The Boulder Narrows Fault is thought to impede ground water flow across the fault (McDonald Morrissey Associates, Inc. 1997).

Siphon Fault. The Siphon Fault separates highly permeable marine carbonate rocks north of the fault from less permeable volcanic rocks south of the fault. As illustrated in Figure 3.2-6, the fault acts as a pronounced barrier that separates the drawdown cone developed from mine dewatering activity north of the fault from the ground water mound developed from the infiltration activities south of the fault (McDonald Morrissey Associates, Inc. 1996b). Wells located on either side of the fault record dramatically different water levels. For example, the water level in monitoring well NA-50D, located east of the Siphon Fault, was 4,375 feet amsl in late 1997, but the water level in monitoring well NA-7D, west of the fault, was 4,759 feet amsl. Both of these wells are completed in volcanic rocks, and their head difference of nearly 400 feet provides strong evidence that the Siphon Fault is a barrier to ground water flow (Barrick 1999b).

Post Fault. The Post Fault generally trends north-south and is exposed in the east wall of the Betze-Post Pit. Near vertical movement along the Post Fault has juxtaposed low permeability marine clastic rocks against the high permeability marine carbonate hydrostratigraphic unit. Exploratory drilling prior to active dewatering in the area revealed a 100-foot drop in ground water elevations across the fault from east to west (BLM 1991a). As mine dewatering has progressed, there has been a dramatic difference in the rates of observed water level decline in wells on either side of the Post Fault. As shown in Figure 3.2-6, much greater water level declines are seen on the west side of the Post Fault than on the east side (McDonald Morrissey Associates, Inc. 1996b). For example, monitoring well PZ95-1D, located on the east side of the Post Fault, had a water level of 4,819 feet amsl at the end of 1997. At the same time, monitoring well PZ96-2D, located on the west side of the fault, had a water level of 4,214 feet amsl. Both of these wells are completed in marine clastic rocks, and the difference in head of approximately 600 feet between the two wells is evidence that the fault is a barrier to ground water flow (McDonald Morrissey Associates, Inc. 1998). Again, this is probably controlled more by the juxtaposition of the different rock types across the fault than by the hydraulic characteristics of the fault itself.

**Geothermal System**. A deep geothermal system exists in the carbonate aquifer in the vicinity of the Betze-Post Pit and Meikle Mine. High-yield wells located within the carbonate aquifer compartment (that extends from the Betze-Post Pit to a distance of approximately 6 miles northwest of the Betze-Post Pit) have reported temperatures at the well head of 140 to 145 degrees Fahrenheit. In contrast, wells drilled into the low-yield, marine clastic rocks located immediately east of the Betze-Post Pit have well-head temperatures that range from 70 to 90 degrees Fahrenheit. Identification and understanding of the deep geothermal system is important to understand the movement of ground water. For specific hydraulic characteristics and head distributions, the rate of

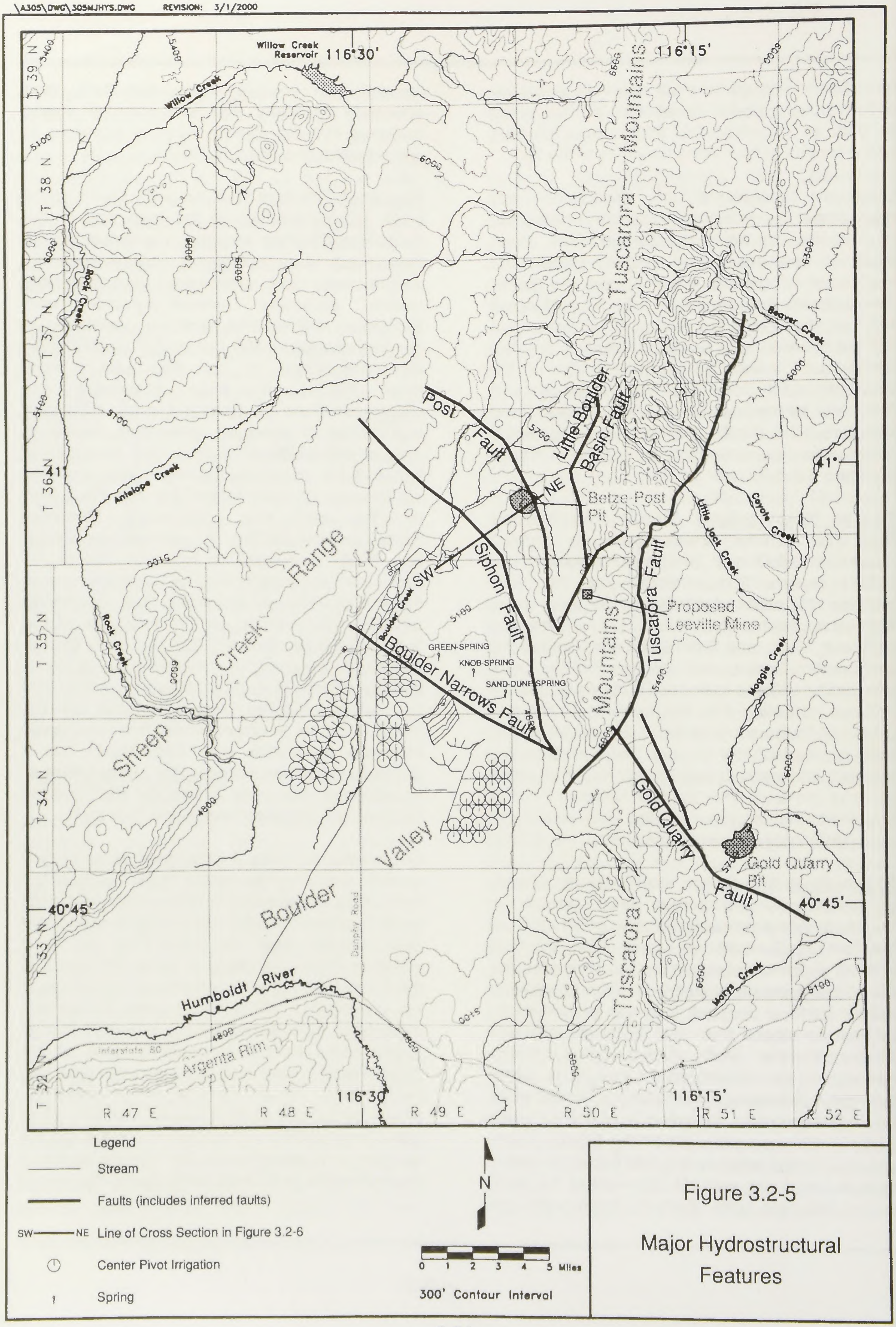


Figure 3.2-5

Major Hydrostructural Features

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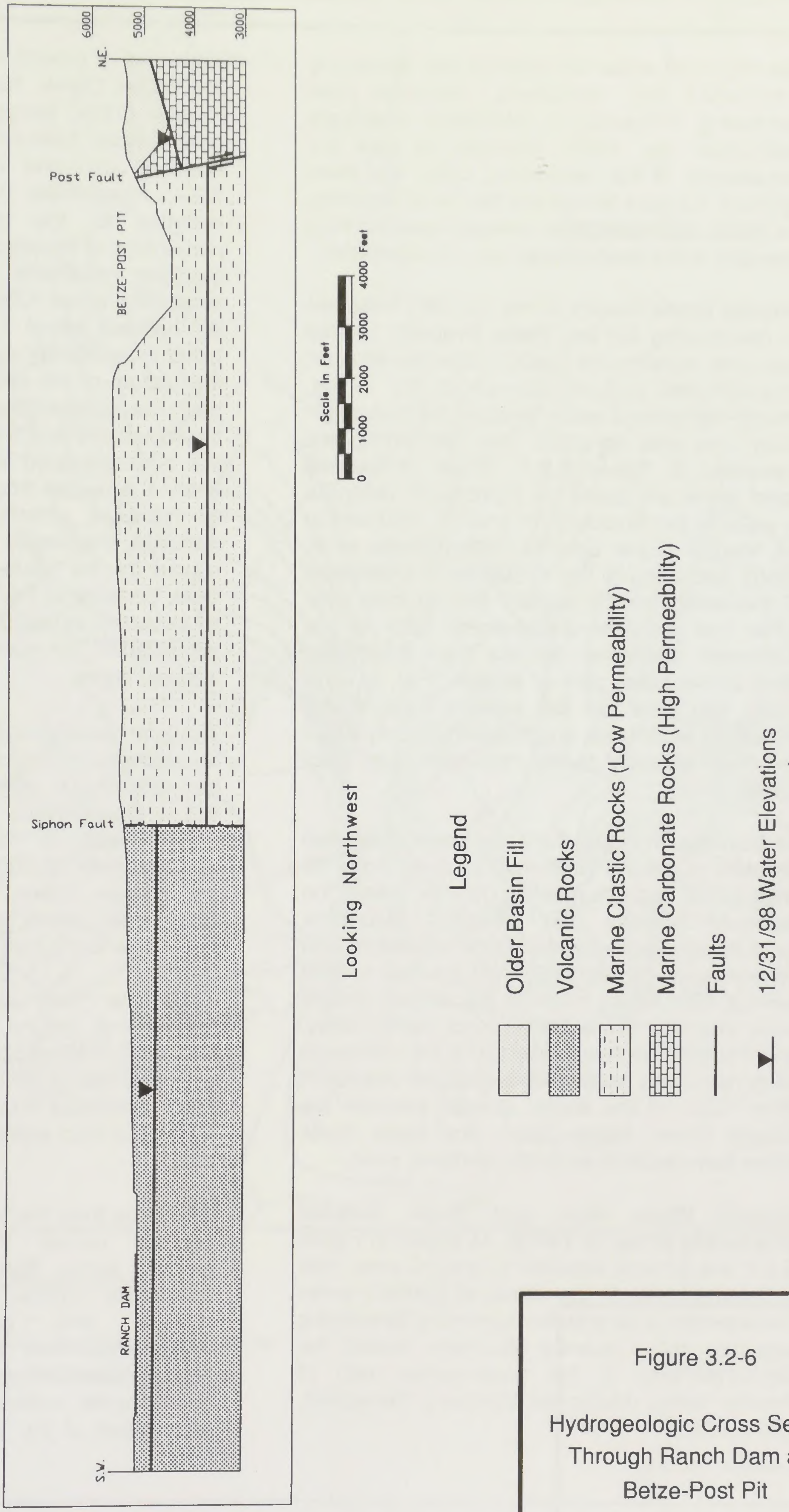

Figure 3.2-6

Hydrogeologic Cross Section Through Ranch Dam and Betze-Post Pit flow of ground water will increase with increasing temperature (or, conversely, decrease with decreasing temperature) (McDonald Morrissey Associates, Inc. 1998). However, to date the temperature of the dewatering water has been relatively constant throughout the life of the mine; therefore, substantial flow changes resulting from changing water temperatures are not anticipated.

**Ground Water Levels (Prior to 1991 Initiation of Dewatering for the Betze Project).** Limited data exist to define the ground water elevation (or potentiometric surface) throughout the region. Unconfined ground water levels in the hydrologic study area prior to active mine dewatering are presented in Figure 3.2-7. These unconfined water levels are based on water levels recorded in wells in the Boulder Flat area in 1990 and in the Maggie Creek area in 1988 (Maurer et al. 1996). According to this evaluation, the elevation of the potentiometric surface ranged from over 5,700 feet amsl on the western flank of the Tuscarora Mountains, to less than 4,600 feet amsl in the lower part of Boulder Flat, to over 5,900 feet amsl on the eastern flank of the Tuscarora Mountains, and to approximately 4,900 feet amsl adjacent to the Humboldt River near Carlin.

As illustrated in Figure 3.2-7, the general, inferred direction of ground water flow is away from the crest of the bedrock mountain blocks toward the basin fill deposits. The Tuscarora Mountains function as a ground water divide separating flow systems west of the divide from the flow system east of the divide. West of the divide, ground water in Willow Creek Valley, Rock Creek Valley, and Boulder Flat flows west out of the hydrologic study area and southwest toward the Humboldt River. East of the divide, ground water in the Maggie Creek, Marys Creek, and Susie Creek areas flows south toward the Humboldt River.

**Ground Water Flow and Water Balance (Premining [Prior to 1991]).** As shown in Figure 3.2-7, the general direction of ground water flow in Boulder Valley in the vicinity of Barrick's water management area prior to major mine dewatering was from the Tuscarora Mountains toward the discharge area in the southwestern part of Boulder Valley (McDonald Morrissey Associates, Inc. 1998).

Estimates of ground water inflow and outflow for the Willow Creek, Rock Creek, Boulder Valley, Maggie Creek, Marys Creek, and Susie Creek ground water basins under premining (pre-Betze Project) conditions are summarized in Table 3.2-4. Precipitation is the ultimate source of recharge to the ground water system. A percentage of the precipitation falling in the higher elevation mountains returns to the atmosphere essentially where it falls. The remainder infiltrates the bedrock where it falls or runs off and then either infiltrates the ground water system through the bottom of the stream channel or leaves the basin as surface flow. Runoff is channelized in the mountains and then tends to rapidly infiltrate the course-grained alluvial fan as the stream channel emerges from the mountains. This type of recharge, referred to as mountain front recharge, is believed to be the primary recharge source for the basin-fill alluvial aquifers. In the lower portions of the basins, negligible recharge is expected to occur from direct infiltration of precipitation, but some infiltration does occur in irrigated areas.

The total recharge to the hydrologic study area is an estimated 82,000 acre-feet/year. This estimate includes 47,000 acre-feet/year received in the Willow Creek, Rock Creek, and Boulder Valley basin areas in the western portion, and approximately 35,000 acre-feet/year received in the Maggie Creek, Marys Creek, and Susie Creek basin areas in the eastern portion of the hydrologic study area.

In Boulder Flat, an estimated 29,000 acre-feet/year of ground water inflow occurs from infiltration of Humboldt River water. An additional 600 acre-feet of ground water inflow to Boulder Flat is estimated to occur from subsurface ground water flow from adjacent basins south of Boulder Flat.

Discharge from the bedrock and alluvial basin-fill aquifers occurs through evapotranspiration, ground water flow leaving the basins as subsurface outflow, discharge to streams and springs, and ground water pumping. Evapotranspiration accounts for an estimated 79,000 acre-feet/year (Maurer et al. 1996) of ground water outflow from the hydrologic study area. West of the Tuscarora Mountains, in the

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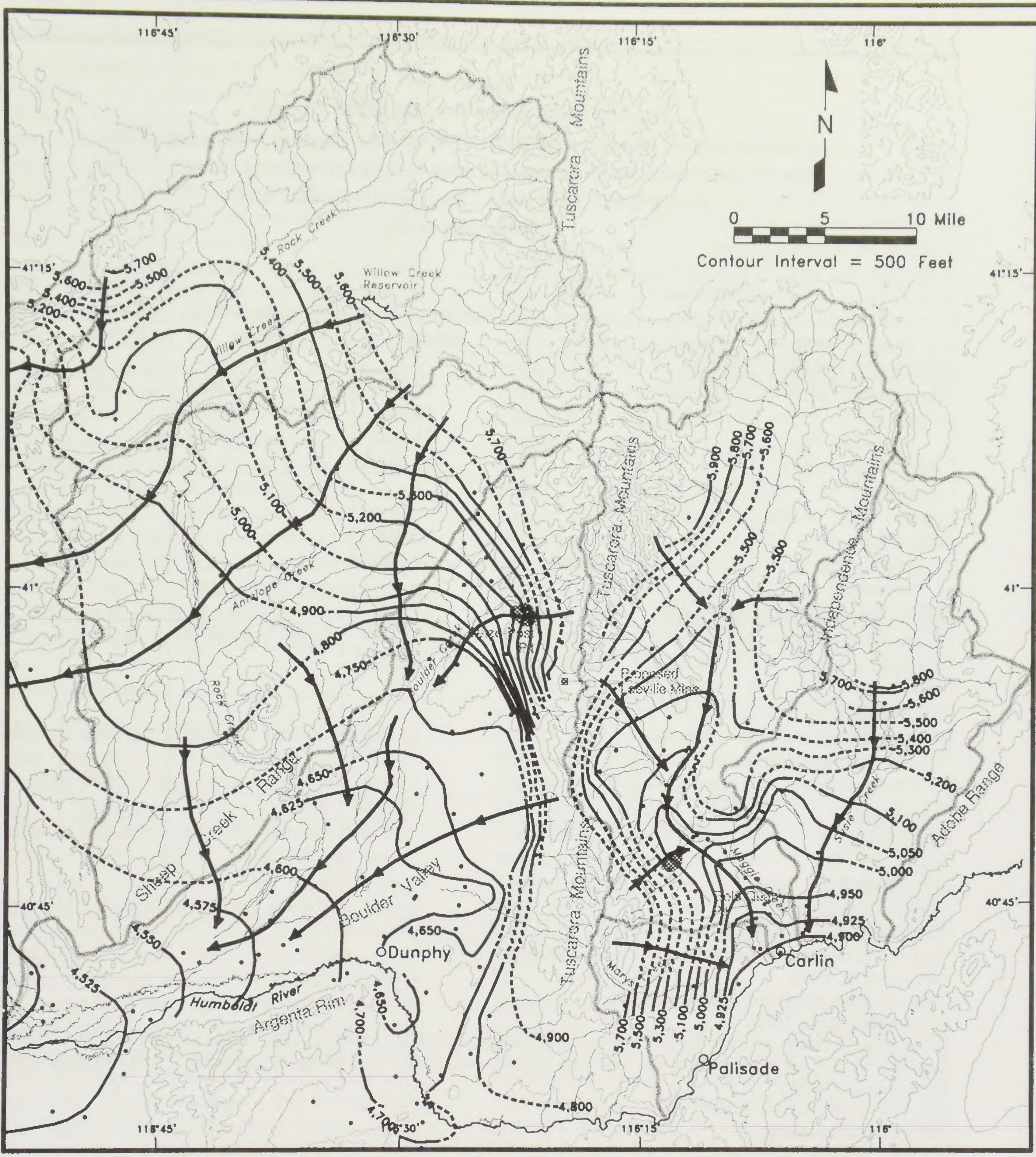

Legend

▨ Ground Water Basin Boundary

Stream

Water-table contour, dashed where uncertain

← General Direction of Ground Water Flow

• Wells

Figure 3.2-7

Unconfined Ground Water Levels, 1990-1991

## Table 3.2-4
## Pre-1991 Estimated Ground Water Budget
## (published and unpublished estimates of water budget components for the Willow Creek, Rock Creek, Boulder Flat, Maggie Creek, Susie Creek, Marys Creek, and Rock Creek ground water basins [acre-feet/year])

| Budget Component | Willow Creek Basin | Rock Creek Basin | Boulder Flat Basin | Maggie Creek Basin | Marys Creek Basin | Susie Creek Basin |
|---|---|---|---|---|---|---|
| **GROUND WATER INFLOW** | | | | | | |
| Recharge (Total) | 20,000[3] | 13,000[3] | 14,000[3] | 23,000[3] | 2,100[3] | 9,700[3] |
| Direct | 14,000[1] | 9,800[1] | 19,300[1] | 16,000[4] -13,900[1] | | |
| Mountain Front | | 6,000[1] | 11,200[1] | 20,200[1] | | |
| Subsurface Inflow | | | 600[3] | | | |
| Infiltration from Rivers and Streams | 0 | 0[1] | 40,000[3] | 0[1] | 0 | 0 |
| Humboldt | | 20,000[1] | 29,000[1] | 0[1] | | |
| Others | | | | | | |
| **GROUND WATER OUTFLOW** | | | | | | |
| Evapotranspiration | 9,000[3] | 4,600[3] | 30,000[4]-51,000[3] | 5,434[5] - 11,000[3] | 2,000[3] | 1,700[3] |
| Subsurface Outflow | 4,300[3] | 2,800[3] | 12,000[3] | 0[3] | 0[3] | 0[3] |
| Discharge to: | | | | | | |
| Humboldt River | 0[3] | 0[3] | 0[3] | 5,700[6] | 500[6] | 2,400[6] |
| Rivers, Streams | | | | | | |
| Springs | | | | | 3,400[3] | |
| Pumpage | | | 3,000[1] | 244[5] | | |
| **SURFACE WATER OUTFLOW** (at Basin Outlet) | N/A | 29,000[2] | N/A | 18,000[3] | 4,200[2] | 9,500[3] |

[1] McDonald Morrissey Associates, Inc. 1998.
[2] McDonald Morrissey Associates, Inc. 1996b, 1997.
[3] Maurer et al. 1996.
[4] Nevada State Engineer's Office 1971a, b.
[5] Plume and Stone 1992.
[6] Total ground water discharge from Susie Creek, Maggie Creek, and Marys Creek areas was estimated at 8,600 acre-feet/year by Maurer et al. (1996); this total was divided among the three areas in proportion to the recharge reported in Maurer et al. (1996).
N/A = No estimates available.
ET = Evapotranspiration.

Willow Creek, Rock Creek, and Boulder Flat basins, an estimated 19,000 acre-feet/year of ground water outflow occurs as flow into the Clovers area located west of the hydrologic study area. An estimated 8,600 acre-feet/year of ground water discharge occurs from the Maggie Creek, Marys Creek, and Susie Creek areas to the Humboldt River; an additional 3,400 acre-feet/year of ground water discharge occurs as spring flow at Carlin Springs and another nearby unnamed spring in the Marys Creek basin (Maurer et al. 1996).

**Ground Water Rights**. According to the records, a total of 234 ground water rights and applications for ground water rights are recorded within the hydrologic study area. Information on these rights and applications for rights is summarized in Appendix A, Table A-1; the point of diversion locations listed for the water right or application for water right are shown in Figure 3.2-8 (Nevada State Engineer's Office 1999, 2000). This inventory does not include rights and applications for rights owned by Barrick or Newmont that are classified as mining and milling. Since water rights are not necessary for most domestic wells, this inventory (based on information on file at the Nevada Division of Water Resources) does not include all domestic or stock watering wells that may exist within the regional study area. However, included in Table A-1 are five known water supply wells that are apparently used for domestic or stock watering and that do not have a water rights permit or application number. Other domestic water supply wells that are not included in this inventory likely exist in the vicinity of Carlin in the southeastern portion of the hydrologic study area. Primary uses for the water are domestic uses, irrigation, stock watering, and mining-related uses.

## Seeps and Springs

All identified springs within the hydrologic study area are shown in Figure 3.2-9 (JBR 1992b, 1990a; RTi 1994; Newmont 1999c; McDonald Morrissey Associates, Inc. 1998; AATA International Inc. 1998a, 1997; Nevada Division of Wildlife 1998b, 1996b, 1978; Valdez et al. 1994; USGS quads). Two field investigations have been conducted to identify perennial seeps and springs located within the region surrounding the Goldstrike Mine. Both inventories were conducted in the fall in order to identify springs with perennial flow that represent discharge from the ground water system. The first inventory was conducted by JBR in the fall of 1989 (JBR 1990a) to identify all seeps and springs located within an approximately 10-mile radius of the Betze-Post Pit. The JBR inventory included Boulder, Bell, Brush, and Rodeo Creek watershed areas. The JBR study identified 131 seeps and springs as summarized in the original Betze Project EIS (BLM 1991a). The second inventory was conducted by RTi in the fall of 1993 (RTi 1994) and extended the area of coverage to approximately 600 square miles. This area included the Willow Creek, Rock Creek, and Antelope Creek watersheds, and springs located in the northern, southern, and eastern portions of the Tuscarora Mountains. The RTi (1994) inventory identified an additional 277 seeps and springs with perceivable flows and 211 seeps with no perceivable flow. The locations of all of the identified seeps and springs are presented in Figure 3.2-9. Springs are not evenly distributed throughout the area; they discharge throughout the Tuscarora Mountains and occur as clusters in the upper and lower Willow Creek area, upper Antelope Creek-Squaw Creek area, and east of the Tuscarora Mountains. Conversely, there are large areas in the Sheep Creek Range-Rock Creek area and lower Boulder Creek-Boulder Valley area that are devoid of identified natural springs.

Flows for all springs identified in the region surrounding the Goldstrike Mine area ranged from less than 1 gpm to 140 gpm, with most springs having discharges of less than 3 gpm. In this area, the flow rate measured in the fall, or low-flow season, for approximately 90 percent of the springs ranged from less than 1 gpm up to approximately 3 gpm. Only four inventoried springs had flows greater than 10 gpm. On the eastern slope of the Tuscarora Mountains (the region east, southeast, and northeast of the Betze-Post Pit) there are numerous springs. The majority of these springs are located at higher elevations (greater than 6,500 feet) in the Tuscarora Mountains. Flow rates for these springs show a similar pattern to springs on the western slope of the Tuscarora Mountains with most having low flow rates (less than 3 gpm). However, a few larger springs occur with flow rates of over 10 gpm.

Several seep and spring studies have been conducted in the region surrounding the Gold Quarry Mine. JBR (1992b) conducted a comprehensive spring and seep inventory in May and June 1992 that identified approximately 200 springs and seeps in this region. In addition, approximately 75 representative springs located within a 10-mile radius of the Gold Quarry Mine have been monitored biannually since 1990 (Newmont 1999c).

Within a 10-mile radial distance of the Gold Quarry Mine, the majority of inventoried springs and seeps have flow rates of less than 5 gpm. Based on measurements from 1991 to 1997 by

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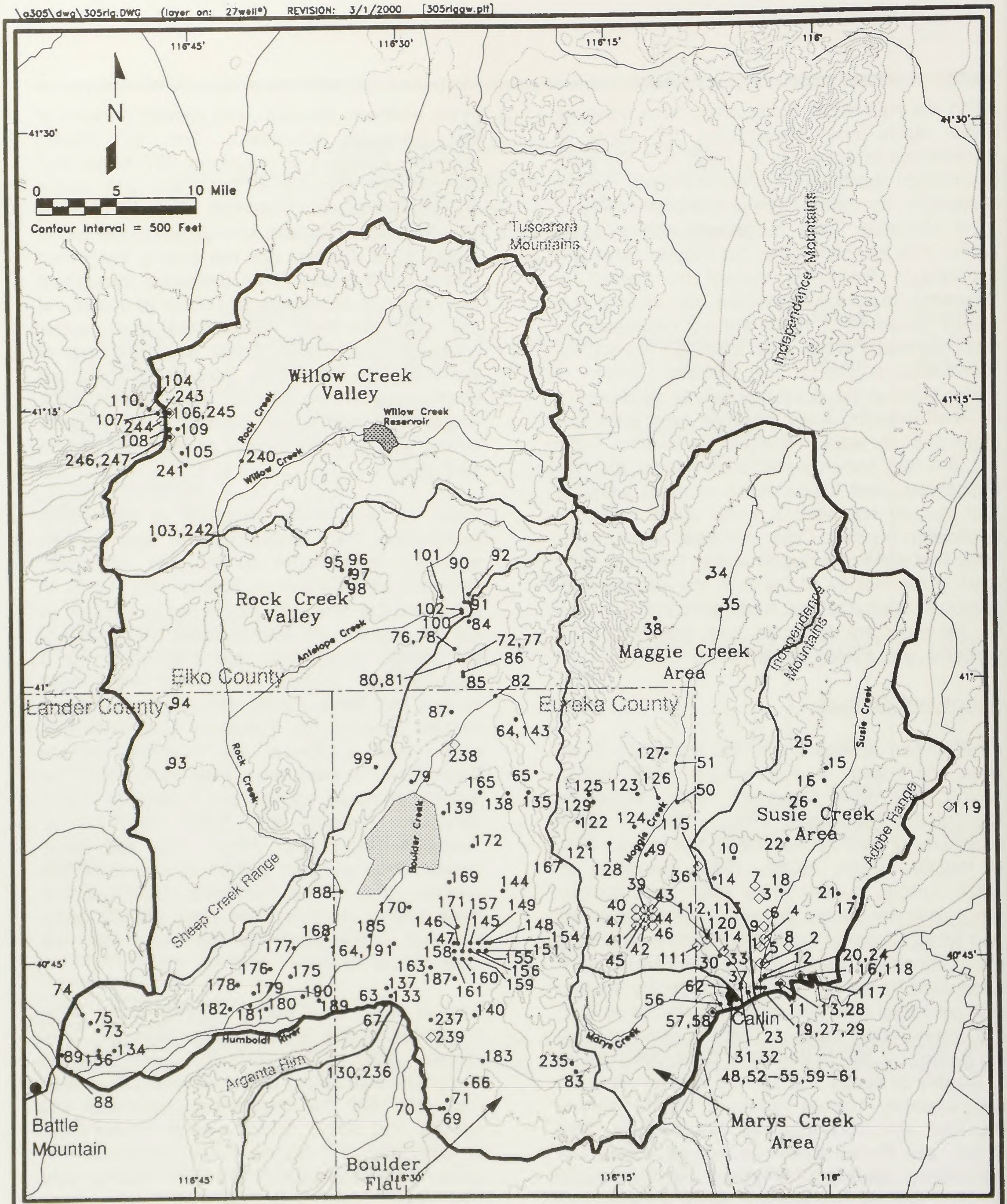

Legend

Study Area

Ground Water Basin Boundary

Stream

County

70• Point of Diversion for Ground Water Right with Current Permit, Certificate, or Vested Status

47◇ Listed Point of Diversion for Applications for Ground Water Right (Application, Ready for Action, and Ready for Action Protested), and other known well locations

▨ This area contains 54 ground water rights and application for ground water rights (Numbers 68, 131, 132, 141, 142, 150, 152 153, 162, 166, 173, 174, 184 186, 192-215, and 218-233). The point of diversion locations are provided in Table A-1.

See Table A-1 for details

Figure 3.2-8

Ground Water Rights, Application for Ground Water Rights, and Other Known Wells in the Hydrologic Study Area

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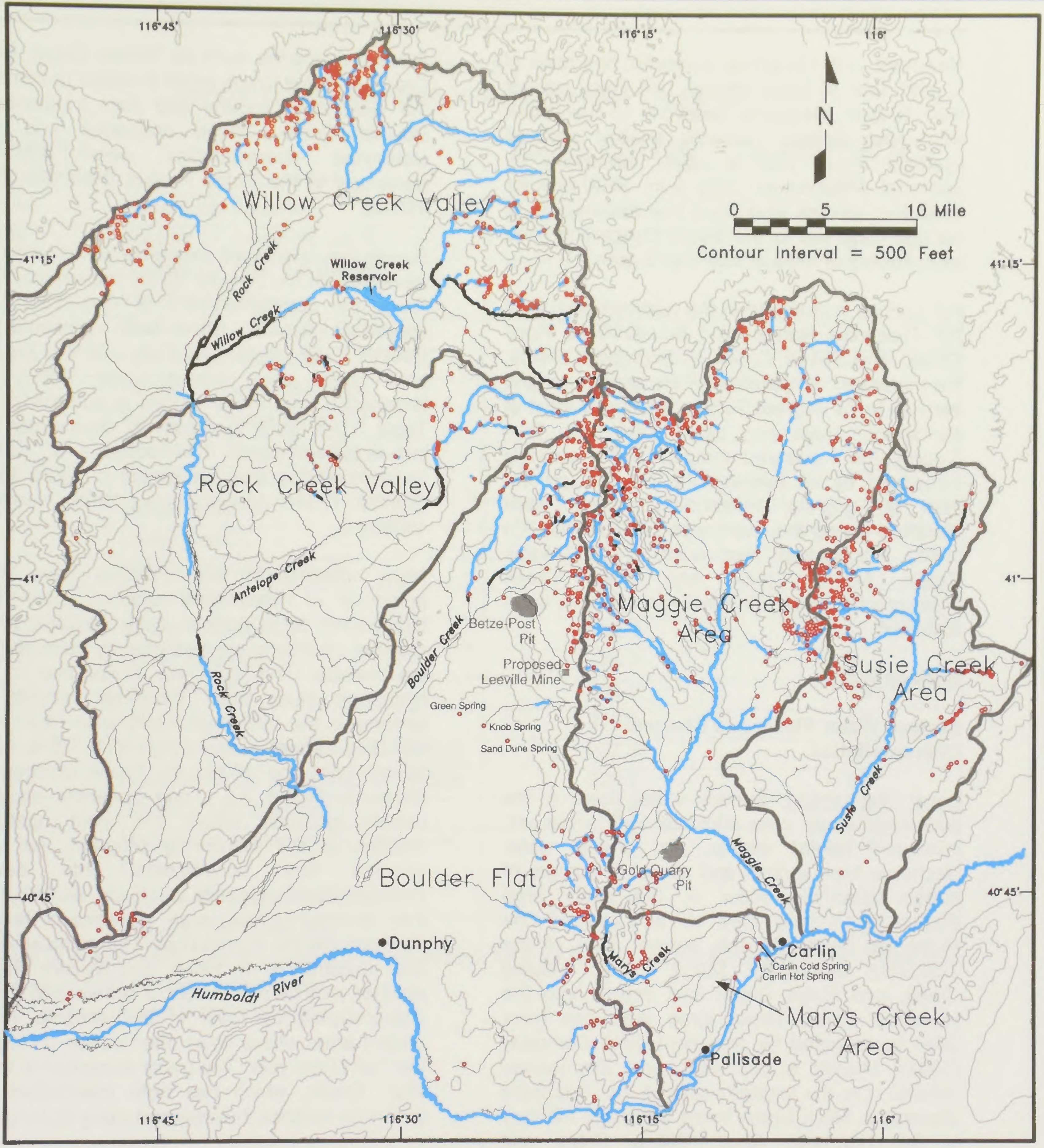


Legend

- Ground Water Basin Boundary
- Stream (Intermittent or Ephemeral)
- Perennial Steam
- Discontinuous Flowing Stream Reach
- ∘ Spring and Seeps

Note: Stream locations are taken from USGS line graph database. Hydrographic Area Boundary locations are approximate.

Figure 3.2-9

Areas of Perennial Stream Reaches, Springs, and Seeps in the Hydrologic Study Area

Newmont, only 12 springs exceeded flow rates of 5 gpm; four of these springs had flows greater than 50 gpm. Seasonal variations in flow occur with most springs, indicating shallow perched systems where flow is easily influenced by seasonal precipitation. Data from BLM files for 1982 field studies also show that the majority of springs observed in the South Operations Area were flowing at rates of less than 5 gpm.

For springs inventoried in the northern portion of the Tuscarora Range, and Boulder Flat, Rock Creek, and Willow Creek Hydrographic basins, the measured temperature of the springs ranged from 38 to 78 degrees Fahrenheit. Since most of the springs have very small flows (less than 3 gpm), the measured temperature is strongly influenced by air temperature. No hot (greater than 90 degrees Fahrenheit) springs were identified during the inventories (JBR 1990a; RTi 1994). For springs inventoried in the Maggie Creek, Marys Creek, and Susie Creek Hydrographic basins, five hot springs have been identified.

## Surface Water

### Surface Water Flows and Channel Characteristics

Local Watersheds. Surface water flows in the hydrologic study area originate from snowmelt, infrequent rainfall events, and ground water discharge from springs and seeps. A number of stream channels occur in the study area (Figure 3.2-1), and they all flow toward the Humboldt River. On the eastern side of the Tuscarora Mountains, Marys Creek, Maggie Creek, and Susie Creek flow directly into the Humboldt River. These three drainages have been investigated by Newmont Gold Company (1991), Maurer et al. 1996, and Zimmerman (1992a). On the western side of the Tuscarora Mountains, Rock Creek forms the major tributary to the Humboldt River. Willow Creek and Antelope Creek are major tributaries to Rock Creek to the north and west of Barrick's operations. Rock Creek traverses the southwest portion of Boulder Flat and receives flow from Blue House Slough as well as the Boulder Creek - White House Ditch - Blue House Ditch system before it joins the Humboldt River near Battle Mountain (Figure 3.2-1).

Smaller drainages such as Rodeo Creek, Brush Creek, and Bell Creek occur in closer proximity to the Goldstrike property and form tributaries to Boulder Creek. These drainages and their watershed characteristics were described previously in the Betze Project Draft EIS (BLM 1991a).

Barrick has conducted extensive water resources monitoring in the Boulder Valley area since 1989. Since the commencement of Goldstrike Mine operations, results have been presented in Boulder Valley Monitoring Plan quarterly reports, which have been issued since 1991. Flow information from these reports is summarized in Table 3.2-5, from upstream to downstream on individual drainages. The locations of surface water monitoring sites are shown in Figure 3.2-10 (Barrick 1999a; Mauer et al. 1996; Newmont 1999d).

Many streams in arid climates have short perennial or intermittent reaches near their headwaters or in narrow rocky canyons where channel conditions are restricted by bedrock near the surface. This generally holds true in the hydrologic study area. Perennial reaches for streams in the hydrologic study area have been identified through field surveys (RTi 1994; AATA International, Inc. 1998a, b). These reaches are shown in Figure 3.2-1 and generally occur in remote locations above the most upstream stations in the monitoring program. As such streams flow downstream onto deeper unconsolidated deposits such as alluvial fans, they commonly lose large amounts of flow to seepage into the channel bed. During most years, flow occurrence in these downstream alluvial reaches may be intermittent or ephemeral. This is demonstrated by most of the streams in the project area, where flows often cease during the last half of the year. The major exception to this is Rock Creek, which has both intermittent and perennial reaches interspersed along its length.

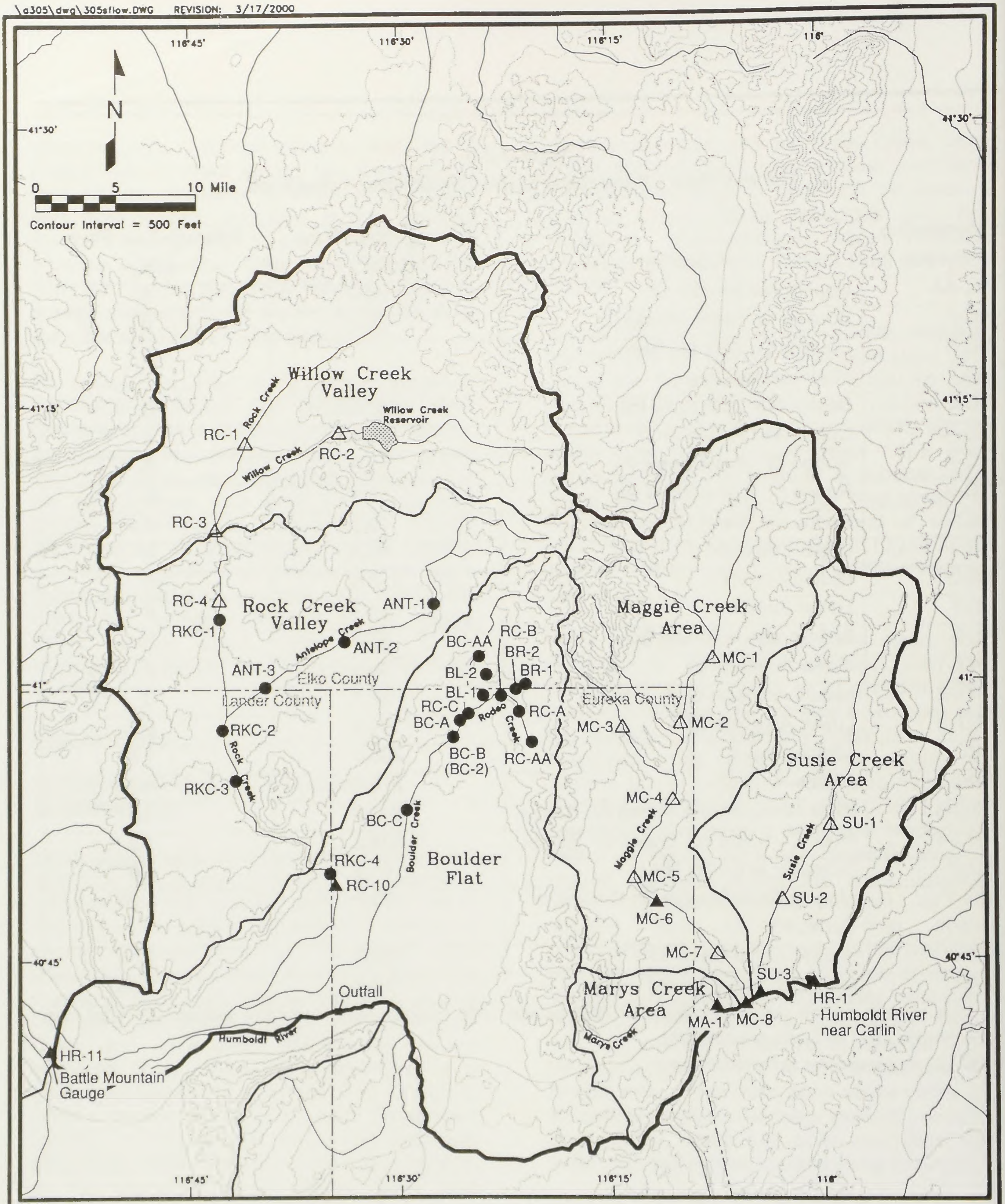
Flow data for selected Boulder Valley streams prior to dewatering activities are available for the Betze Project EIS (BLM 1991a, b). These data indicate that Rodeo Creek was ephemeral in its uppermost reach (approximately one-third of its overall length), but flowed perennially because of springflow contributions immediately downstream. Proceeding downstream, the creek flowed during

## Table 3.2-5
## General Flow Characteristics, Humboldt River Tributaries[1]

| Monitoring Station | Location | Average High Flow (cfs) | Average Low Flow (cfs) |
|---|---|---|---|
| BC-AA | Uppermost Boulder Cr. | 50.6 | 0 |
| BC-A | Boulder Cr. below Rodeo Cr. | 64.3 | 0 |
| BC-B[2] | Boulder Cr. near the Barrick treatment facilities | | 0 |
| BC-C | Boulder Cr. at Dunphy Rd. | 52.3 | 0 |
| RC-AA | Uppermost Rodeo Cr. | 1.1 | 0 |
| RC-A | Rodeo Cr. above Betze Pit | 3.9 | 0 |
| RC-B | Rodeo Cr. below Betze Pit | 3.0 | 0 |
| RC-C | Rodeo Cr. above Boulder Cr. | 19.3 | 0 |
| BR-1 | Upper Brush Cr. | 13.3 | 0 |
| BR-2 | Middle Brush Cr. | 5.6 | 0 |
| BL-1 | Lower Bell Cr. | 14.4 | 0 |
| BL-2 | Bell Cr. above Rodeo Cr. | 20.8 | 0 |
| ANT-1 | Upper Antelope Cr. | 38.6 | 0 |
| ANT-2 | Middle Antelope Cr. | 38.1 | 0 |
| ANT-3 | Lower Antelope Cr. | 34.0 | 0 |
| RKC-1 | Middle Rock Cr | 208.0 | 1.8 |
| RKC-2 | Middle Rock Cr. | 216.8 | 1.3 |
| RKC-3 | Rock Cr. above the Sheep Cr. Range | 207.3 | 1.8 |
| RKC-4[2] | Rock Cr. below the Sheep Cr. Range | 328.2 | 1.8 |
| SU-3[2] | Susie Cr. at Carlin, NV | 63.8 | 0.0 |
| MC-5[2] | Maggie Cr. at Maggie Cr. Canyon nr. Carlin, NV | 73.2 | 1.08 |
| MC-8[2] | Maggie Cr. at Carlin, NV | 102.0 | 4.09 |
| MA-1[2] | Marys Cr. at Carlin, NV | 13.7 | 3.05 |

[1] Average of peak monthly data as available for 1993 through 1998 for Rock Creek tributaries and various dates from 1989 through 1997 for Carlin area streams.

[2] A USGS gage is present at these locations.



Legend

| | |
|---|---|
| ▬ | Study Area |
| — | Ground Water Basin Boundary |
| HR-1 ▲ | USGS Active Streamflow Site ① |
| MC-7 △ | Former USGS Streamflow Site ① |
| BC-C ● | Barrick Surface Water Sampling Locations ② |

① Abbreviations:
HR = Humboldt River; MC = Maggie Creek; BC = Boulder Creek; RC = Rock Creek and its tributaries

② Abbreviations:
RKC = Rock Creek; ANT = Antelope Creek; BC = Boulder Creek; BL = Bell Creek; BR = Brush Creek; and RC = Rodeo Creek

Figure 3.2-10

Streamflow Measurement Sites, Humboldt River Tributaries a substantial part of the year, but flows diminished or ceased in late summer and fall. The stream was intermittent to ephemeral in the lower third of its length above Boulder Creek. The short perennial reaches interspersed along Rodeo Creek were largely a result of springflows along the channel.

According to the earlier baseline information (1988 through 1990), Bell Creek flowed perennially in its upper reaches, becoming intermittent approximately 2 miles above its confluence with Rodeo Creek. Subsurface flow maintained perennial pools that were observed by agency personnel over a short section of the lower intermittent reach. Brush Creek was perennial in its upper headwater reach and along its middle reach on the valley alluvium. It became ephemeral downstream approximately 1 mile above its confluence with Rodeo Creek. Boulder Creek was perennial in its upper headwater reaches, primarily because of springflow contributions. Flows became ephemeral approximately 1 mile above the confluence with Rodeo Creek and remained so downstream (BLM 1991a, b).

Based on recent data from the Boulder Valley Monitoring Plan (Barrick 1999c), Boulder Creek appears to be a predominantly losing stream (flow seeping from the channel to ground water recharge) in the vicinity of Barrick's operations, during both high-flow and low-flow seasons. The stream is perennial in its uppermost reaches and intermittent in the vicinity of the Goldstrike property. Substantial decreases in streamflow occur as Boulder Creek leaves its canyon headwaters and moves onto the valley alluvium in the vicinity of Barrick's treatment facilities. Downstream of Barrick's mining and processing operations, Boulder Creek is an ephemeral channel; based on records since 1991, it flows only in response to snowmelt or the occasional local thunderstorm. Rodeo Creek appears to lose flow in spite of its increasing watershed area until it is joined by Bell Creek. Below that confluence, Rodeo Creek flows substantially increase due to contributions from Bell Creek, but slight seepage losses to the alluvium may occur. Brush Creek flows do not exhibit a consistent pattern of losses or gains. Antelope Creek data for 1996 and 1997 do not indicate a discernible pattern of losses or gains, but it is probable that some flow was lost to recharge to valley alluvium along the middle and lower reaches. During the low flow season in 1993, the upper reaches of Antelope Creek and Squaw Creek (located 5 to 7 miles north of the Betze-Post Pit) exhibited flows of 15 to 20 gpm (RTi 1994). Although flows that year were 50 to 70 percent higher than average regionally, these suggest that perennial flows exist on these streams in the locale. These stream reaches are shown in Figure 3.2-9. Approximately 4 miles below its headwater springs, Antelope Creek had flows of approximately 15 gpm. Below this point, gaining and losing reaches alternated over short distances depending on springflow contributions and channel seepage. On September 30, 1993, Squaw Creek at its mouth contributed approximately 20 gpm to Antelope Creek, but a short distance downstream the latter was flowing at only 17 gpm. Approximately 2.5 miles farther downstream, Antelope Creek flowed at 22 gpm; another 3.5 miles farther downstream, the stream was dry (RTi 1994).

This last location approximates the most upstream monitoring station (ANT-1) for Antelope Creek in the Boulder Valley Monitoring Plan. The location of this station also is known as RC-6 (designation per Maurer et al. 1996). Data in the Boulder Valley Monitoring Plan through 1998 also indicate that Antelope Creek goes dry at this location during the late summer. Maurer et al. (1996) indicate that Antelope Creek is dominantly an ephemeral stream along its length, except for short reaches sustained by small ground water baseflows.

Rock Creek and its tributary, Willow Creek, are the principal streams in Willow Creek Valley northwest of Barrick's operations. Streamflows in both Willow Creek and Rock Creek downstream of their confluence are affected by irrigation diversions and releases from Willow Creek Reservoir. Both gaining and losing measurements were made in this area, but typically these upper reaches are probably gaining flows from ground water contributions (Maurer et al. 1996). Also, a discharge location known as Hot Lake occurs in the northern portion of the Rock Creek drainage near the confluence of Rock Creek and Willow Creek (Figure 3.2-10). This feature is a major discharge area that supplies most of the water in Rock Creek in the vicinity during low-flow periods. The name Hot

Lake is misleading because the water is similar in temperature to other flows in the area, which have normal surface water temperatures. Examination of the topography in the south end of Squaw Valley suggests that it is possible for the water in Rock Creek and the irrigated agricultural areas northeast of Hot Lake to move in the alluvium until a subsurface barrier is encountered near the hills in the vicinity of the lake. Such a barrier could force water to surface at Hot Lake. The flow may be a combination of water from Willow Creek, Rock Creek, and other watersheds in the area.

Along its length through Rock Creek Valley, the Sheep Creek Range, and Boulder Valley, Rock Creek exhibits both baseflow gaining reaches (flow returning to the channel from ground water contributions) and losing reaches (flow leaving the channel by seepage or other means). These fluctuations depend primarily on the amount of precipitation as well as contributions from Willow Creek Reservoir (see Figure 3.2-9). In Rock Creek Valley north of the Sheep Creek Range, Rock Creek typically loses flow to the valley alluvium as does Antelope Creek. Contributions to flows in Rock Creek from Antelope Creek are likely to be insignificant, given the ephemeral nature of Antelope Creek in the vicinity. Near or within the Sheep Creek Range farther downstream, Rock Creek may gain or lose flows depending on geologic factors and the occurrence of precipitation or snowmelt in different years. Still farther downstream, historical USGS gaging data suggest that flows are small but perennial just as the stream leaves the Sheep Creek Range. However, during lengthy drought periods such as the early 1990s, Rock Creek may go dry in this vicinity. Rock Creek frequently goes dry during the summer months within Boulder Valley farther downstream of the Sheep Creek Range.

Available data and interpretations for Susie Creek, Maggie Creek, and Marys Creek represent gaging conducted by the USGS and Newmont. Most of these data have been collected during a relatively short period from the late 1980s. The middle portion of Susie Creek gains flow, possibly from small tributary contributions or from ground water inflows. Farther downstream in its lower reach, the channel loses flows by seepage into the underlying aquifer. Periods of no flow occur during the summer and fall (Maurer et al. 1996; Newmont 1999d).

Maggie Creek is the principal creek located just east of the Newmont South Operations Area in Maggie Creek basin. Maggie Creek flows 41 miles southward to its confluence with the Humboldt River near Carlin. James, Soap, Simon, Cottonwood, Jack, Little Jack, Coyote, Spring, Haskell, Beaver, and Taylor creeks are tributaries of Maggie Creek. The Maggie Creek drainage area is approximately 400 square miles. Immediately north of the South Operations Area, Maggie Creek is confined by Maggie Creek Canyon, or the "narrows." This bedrock feature divides the Maggie Creek basin into upper and lower basins. Maggie Creek generally flows as a perennial stream above the canyon and as an intermittent stream through most of the lower basin.

Flow gaging on Maggie Creek by the USGS was continuous from 1913 until 1924 at a station located above its confluence with the Humboldt River. Currently, the USGS operates three gaging stations on Maggie Creek, installed in 1989, 1992, and 1996. During the 1913 to 1924 period of record, average daily discharge of lower Maggie Creek was 23.2 cfs. In general, average monthly flow in Maggie Creek at the mouth is less than 10 cfs during 7 months of the year and approximately 100 cfs during the months of April and May. High flows in Maggie Creek occurred in March 1993 and March 1996 with more than 100 cfs measured at all stations. In summer and fall, lower Maggie Creek commonly dries up while upper Maggie Creek maintains flow rates of 0.2 to 0.5 cfs.

Maggie Creek has both gaining and losing reaches along its length. The USGS has measured flow at several locations along Maggie Creek on the same day to evaluate water gain or loss. Flow measurements during the period 1988-92 suggest that Maggie Creek gains in flow above Maggie Creek Canyon and loses water through and below the canyon (USGS 1992). In its upper reach the stream loses flows, with losses ranging from approximately 0.5 to 1.2 cfs. The middle reach of Maggie Creek (to Maggie Creek Canyon) is an inconsistently gaining or losing reach depending on specific location, year, or season. Farther downstream, flows are lost along the length of Maggie Creek Canyon. Lower Maggie Creek, from the canyon to the mouth, is a generally losing reach except during occasional snowmelt contributions from the intervening watershed area (Maurer et al. 1996; Newmont 1999d).

Susie Creek flows 29 miles south to the Humboldt River and has a drainage area of approximately 212 square miles. A USGS surface water station was installed near the mouth of Susie Creek in April 1992. In addition, Newmont has established five streamflow measurement sites along Susie Creek. The segment of stream located in the immediate vicinity of the USGS gaging station (for about 1 mile upstream) dries up during the summer on an annual basis. However, above this reach, lower Susie Creek is perennial in most years. The single exception in recent years was during the 1994 drought when portions of lower Susie Creek, that are normally perennial, went dry. Susie Creek flow was measured by the USGS at a point 16 miles above its confluence with the Humboldt River during the period 1956 to 1958. Average annual flow at this location was approximately 6 cfs with average monthly flows ranging from 0.11 to 29.3 cfs (USGS 1963). Maximum annual flows for the 3 years of measurement were 184, 161, and 89 cfs (USGS 1963). Flow data on file with BLM show a high flow of 60 cfs recorded for April 30, 1985, at a location approximately 4 miles above Susie Creek's mouth. At the USGS surface water station on Susie Creek near its mouth, average annual flow is approximately 8 cfs for the period 1992 to 1996. In 1996, April flows peaked at approximately 276 cfs, and Susie Creek was dry from July through October (USGS 1999c). The middle portion of Susie Creek gains flow, possibly from small tributary contributions or from ground water inflows. Farther downstream in its lower reach, the channel loses flows by seepage into the lower aquifer.

Marys Creek flows approximately 13 miles southeast before entering the Humboldt River west of Carlin. The Marys Creek drainage area is approximately 75 square miles. A continuous-recording USGS stream gage has been operating on Marys Creek below the Carlin Springs since November 1989 (Lower Marys). In addition, Newmont maintains one streamflow measurement site along Marys Creek. Depending on the location, Marys Creek may be an ephemeral or intermittent stream, with the exception of the lowermost reach, which is sustained by spring flow from Carlin Spring. Flow characterization by the USGS based on gaging during the last part of the 1985 to 1993 drought indicates an ephemeral regime. Data collected in the uppermost reaches by Newmont from 1993 through 1998, however, indicate small flows occur year-round in the headwaters (Newmont 1999b). Although 1993 was a wet year (based on river flow at Carlin), 1994 was dryer than normal. These flows are probably lost to channel seepage as the stream traverses valley alluvium downstream.

High flows typically are recorded in March and April and low flows in October and November. Flow at the surface water station typically shows a sharp decline in April or May corresponding to the start of irrigation on the Maggie Creek Ranch upgradient from the Carlin Springs (Newmont 1999d). The city of Carlin also obtains some municipal water from the springs, which affects flow measurements downstream at the surface water station. The gage shows maximum and minimum discharges of 400 and 0.6 cfs, respectively (USGS 1999c).

Tributary Channel Characteristics. Channel conditions and flow conveyances for Boulder Creek and Rock Creek have been investigated as part of Barrick's water management program (Simons & Associates, Inc. 1995a). The natural channel cross-sections have a wide trapezoidal configuration or a shallow V-shape; these are asymmetric at bends. Over most of the length of upper Boulder Creek, the bankfull width:depth ratio is on the order of 35. The bed is composed mainly of cobbles and gravels, and the stream exhibits a relatively small amount of meandering until it reaches lower Boulder Valley. Channel slopes in the upper reaches of Boulder Creek near Barrick's operations are approximately 33 feet per mile and flatten to approximately 5 feet per mile in the downstream portions of Boulder Valley.

Rock Creek is moderately meandering in the upper part of its length in Boulder Valley; it becomes highly sinuous downstream as it approaches the Humboldt River. Width:depth ratios along Rock Creek are generally on the order of 16 in the lower reaches near the Humboldt River. The stream sediments are typically sands and silts. The channel slope along Rock Creek as it enters Boulder Valley is approximately 32 feet per mile; this slope flattens to approximately 4 feet per mile near the Humboldt River.

**Surface Water Rights.** An inventory of surface water rights and applications for surface water rights provided information on locations and status within the hydrologic study area.

According to the Nevada Division of Water Resources records, a total of 121 water rights and an additional 6 applications under *ready for actions* status are listed in the state database. Of the 121 water rights, 46 have *certificated* status, 38 are *vested* water rights, 24 have *permit* status, 9 are listed as *proofs* (or decreed water rights), and 4 are under *reserved* water rights status. Information on these rights and applications for rights is summarized in Appendix A, Table A-2; the point of diversion locations are shown in Figure 3.2-11 (Nevada State Engineer's Office 1999, 2000). Note that the inventory excluded all rights and applications for rights owned by Barrick or Newmont for mining and milling use. The primary uses for the water are stock watering, municipal uses, irrigation, and domestic uses.

## Water Quality

**Ground Water Quality Standards.** Standards for protecting ground water used as a drinking water source have been adopted by the Nevada Bureau of Health Protection Services. Specifically, Nevada Administrative Code 445A.453 establishes primary standards in the form of maximum contaminant levels, and Nevada Administrative Code 445A.455 establishes secondary standards, also as maximum contaminant levels. Primary maximum contaminant levels are established to protect human health from potentially toxic substances in drinking water, while secondary maximum contaminant levels are established to protect aesthetic qualities of drinking water, such as taste, odor, and appearance. Since ground water in the vicinity of the project area is used or is potentially usable as a drinking water source, Nevada primary and secondary maximum contaminant levels listed in Table 3.2-6 would apply to the protection of area ground waters. In addition, Nevada's regulations governing mining facilities specifically state that ground water quality cannot be degraded beyond established maximum contaminant levels. If the ground water quality already exceeds maximum contaminant levels, the quality of the ground water may not be lowered to a level that would render the waters unsuitable for the existing or potential municipal, industrial, domestic, or agricultural use (Nevada Administrative Code 445A.424).

**Ground Water Quality**. Ground water quality near the Goldstrike Mine was characterized as part of the original Betze Project Draft EIS (BLM 1991a) and from 61 wells in the Betze-Screamer Pit Lake Study (Radian International, LLC and Baker Consultants, Inc. 1997b). In addition, a ground water chemistry database consisting of 36 selected regional wells (Barrick 1998a) was used to characterize the water chemistry of the Boulder Valley alluvium and tertiary volcanics. The locations of these regional well sites are shown in Figure 3.2-12 (Balleau Groundwater Consulting 1995).

The chemistry of ground water is a result of the chemical characteristics of the source water and the geochemistry of the rocks through which the ground water flows. In the original Betze Project Draft EIS (BLM 1991a), exploration drill holes and springs were used to sample ground water from the Carlin Formation, intrusive rocks (granodiorite), and Paleozoic sedimentary rocks. This analysis expands on the original EIS and includes ground water analyses from volcanic rocks and alluvium, as well as additional analyses from the Carlin Formation, intrusive rocks, and Paleozoic sedimentary rocks (marine clastic and marine carbonate rocks).

The general ground water chemistry for the six major hydrostratigraphic units defined for the region is presented in Table 3.2-7.

Major Constituents. Relative concentrations of the major ions dissolved in each formation water are graphically depicted on a trilinear diagram in Figure 3.2-13 (Radian International, LLC and Baker Consultants, Inc. 1997b). In addition, the following paragraphs summarize the ground

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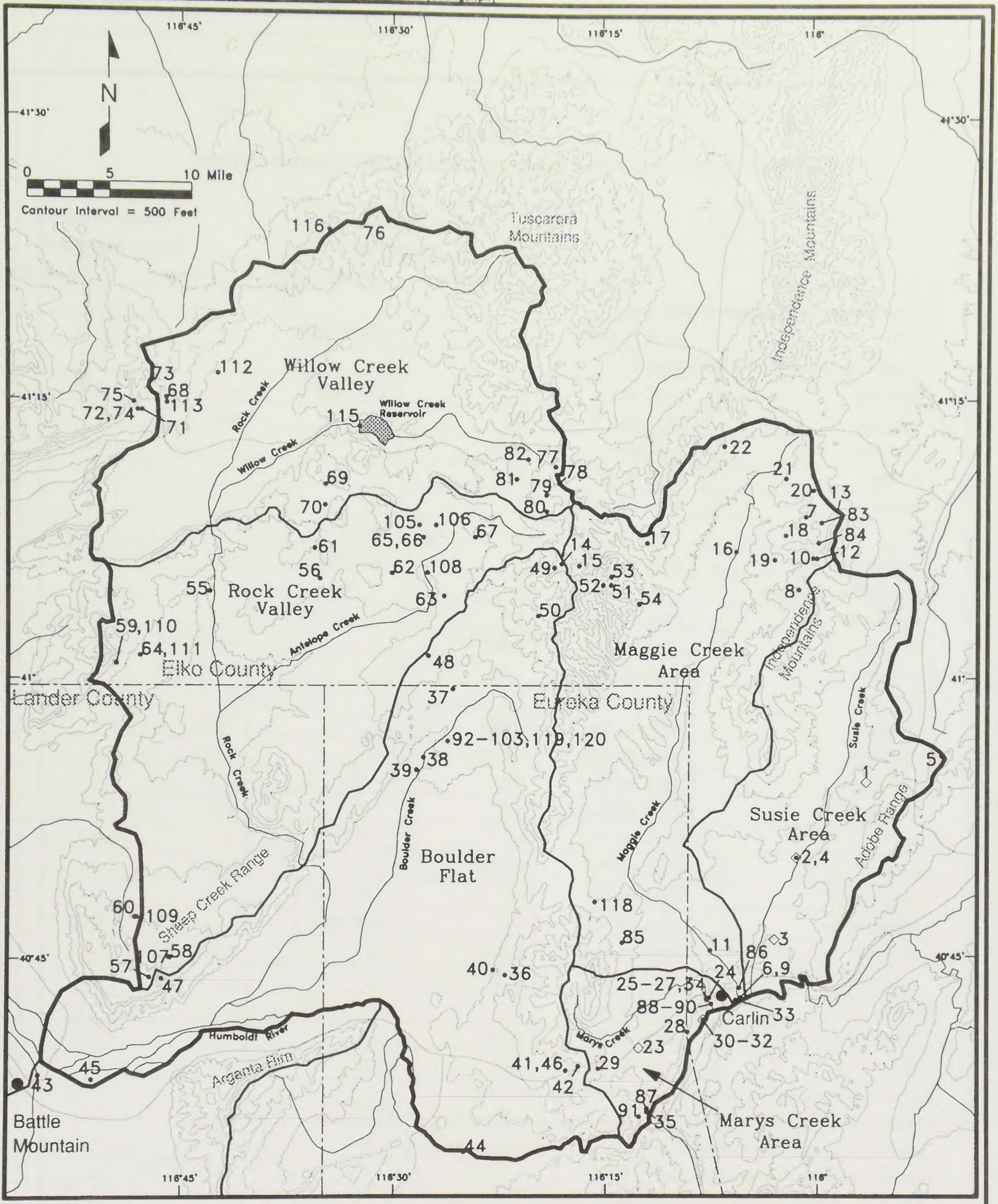

Legend

- ▬▬ Study Area
- —— Ground Water Basin Boundary
- —— Stream
- —·—·— County
- 46• Point of Diversion for Surface Water with Current Permit, Certificate, or Vested Status
- 23◇ Listed Point of Diversion for Applications for Surface Water Right (Application, Ready for Action, and Ready for Action Protested)

See Table A-2 for details

Figure 3.2-11

Surface Water Rights, and Application for Surface Water Rights in the Hydrologic Study Area

## Table 3.2-6
## Drinking Water Standards Applicable to Ground Water

| | | Nevada Drinking Water Standards | | Federal Drinking Water Standards | |
|---|---|---|---|---|---|
| **Constituent** | **Units** | **Primary** | **Secondary** | **Primary** | **Secondary** |
| **Physical and Aggregate Properties** | | | | | |
| TDS | mg/L @180°C | --- | 500[1]/1000[2] | --- | 500 |
| **Inorganic Nonmetallic Constituents** | | | | | |
| Chloride | mg/L as Cl | --- | 250[1]/400[2] | --- | 250 |
| Cyanide | mg/L as CN | 0.2 | --- | 0.2 | --- |
| Fluoride | mg/L as F | 4 | --- | 4 | 2.0 |
| Nitrate | mg/L as N | 10 | --- | 10 | --- |
| Nitrite | mg/L as N | 1 | --- | 1 | --- |
| pH | standard units | --- | (6.5-8.5)[1] | --- | 6.5-8.5 |
| Sulfate | mg/L as $SO_4$ | --- | 250[1]/500[2] | --- | 250 |
| **Metals/Semimetals** | | | | | |
| Aluminum | mg/L as Al | --- | --- | --- | 0.05 to 0.2 |
| Antimony | mg/L as Sb | 0.006 | --- | 0.006 | --- |
| Arsenic | mg/L as As | 0.05 | --- | 0.05 | |
| Barium | mg/L as Ba | 2 | --- | 2 | --- |
| Beryllium | mg/L as Be | 0.004 | --- | 0.004 | --- |
| Cadmium | mg/L as Cd | 0.005 | --- | 0.005 | --- |
| Chromium | mg/L as Cr | 0.1 | --- | 0.1 | --- |
| Copper | mg/L as Cu | 1.3[3] | 1.0[1] | 1.3[3] | 1.0 |
| Iron | mg/L as Fe | --- | 0.3[1]/0.6[2] | --- | 0.3 |
| Lead | mg/L as Pb | 0.015[3] | --- | 0.015[3] | --- |
| Magnesium | mg/L as Mg | --- | 125[1]/150[2] | --- | --- |
| Manganese | mg/L as Mn | --- | 0.05[1]/0.1[2] | --- | 0.05 |
| Mercury | mg/L as Hg | 0.002 | --- | 0.002 | --- |
| Selenium | mg/L as Se | 0.05 | --- | 0.05 | --- |
| Silver | mg/L as Ag | --- | --- | --- | 0.1 |
| Thallium | mg/L as Tl | 0.002 | --- | 0.002 | --- |
| Zinc | mg/L as Zn | --- | 5.0[1] | --- | 5 |

Sources: Nevada Administrative Code 445A.453, and 445A.455.

Federal Drinking Water Regulations and Health Advisories (EPA822-B-96-002) Oct. 96.

[1] Nevada Secondary recommended maximum contaminant levels (MCLs).

[2] Nevada Secondary (Enforceable) MCL.

[3] Federal Treatment Technique (Action Level for Lead and Copper Rule).

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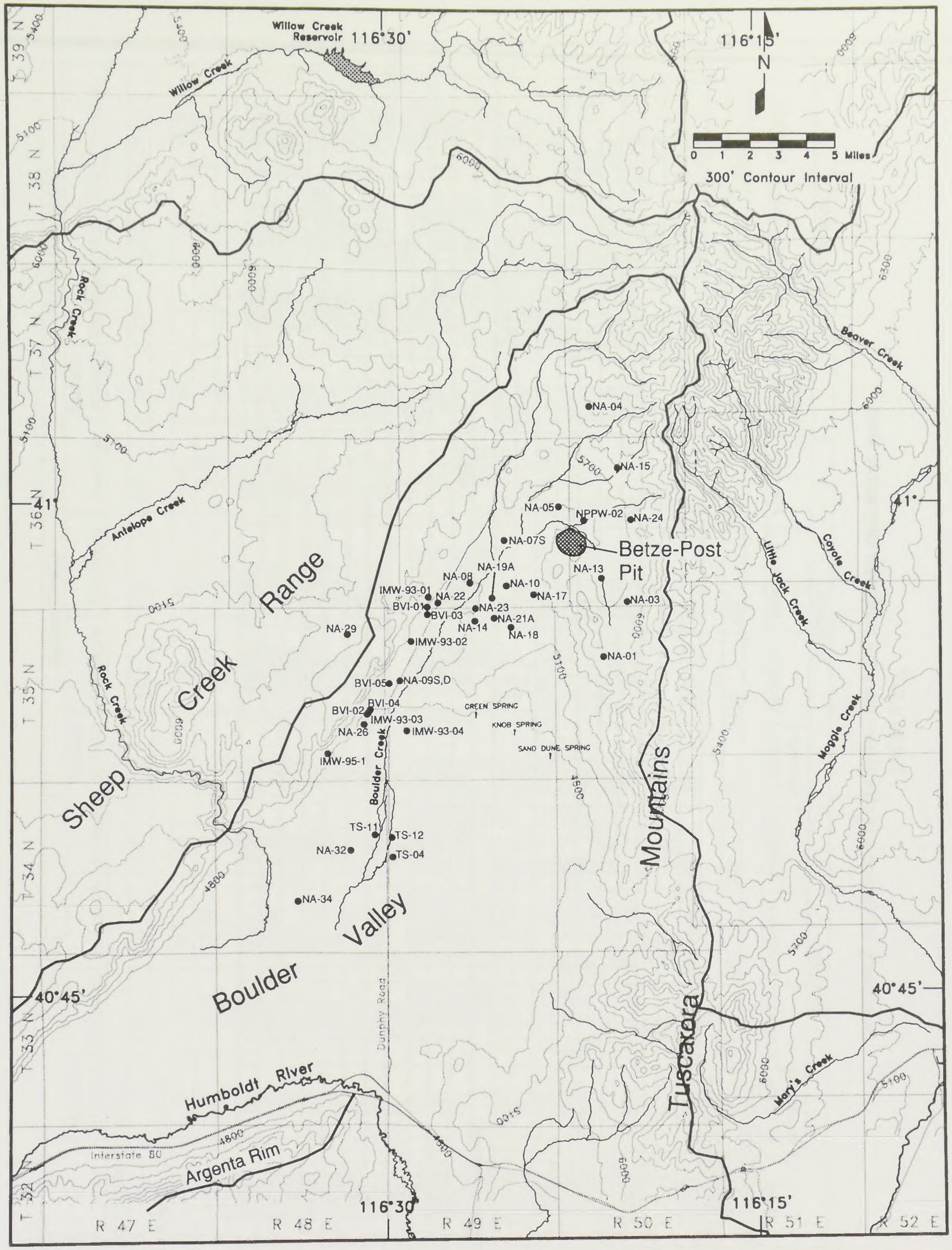

Legend

Stream

Ground Water Basin Boundary

Road

GREEN SPRING Spring

NA-32● Water Quality Well

Figure 3.2-12

Selected Regional Water Quality Monitoring Wells

## Table 3.2-7
## Summary of Ground Water Chemistry by Hydrostratigraphic Unit

| | | Alluvium[1] | | | | Volcanic[1] | | | | Carlin Formation[2] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Constituent | Units | Number of Wells | Minimum | Maximum | Average | Number of Wells | Minimum | Maximum | Average | Number of Wells | Minimum | Maximum | Average |
| **Physical and Aggregate Properties** | | | | | | | | | | | | | |
| TDS | (mg/L) | 10 | 160 | 750 | 323 | 20 | 170 | 760 | 375 | 16 | 180 | 630 | 478 |
| **Inorganic Nonmetallic Constituents** | | | | | | | | | | | | | |
| Chloride | (mg/L) | 10 | 6.7 | 82 | 23 | 20 | 11.0 | 64 | 21 | 16 | 4.0 | 41.0 | 16.6 |
| Fluoride | (mg/L) | 10 | 0.24 | 2.8 | 0.64 | 20 | | 3 | 1.4 | 16 | 0.29 | 1.60 | 1.14 |
| pH | (pH units) | 10 | 7.0 | 8.9 | 7.6 | 20 | 3.5 | 9.3 | 7.7 | 16 | 6.3 | 9.8 | 7.4 |
| Sulfate | (mg/L) | 10 | 20 | 82 | 45 | 20 | 11.0 | 180 | 58 | 16 | 29.0 | 130.0 | 73.2 |
| Temperature | (degrees C) | 10 | 9.0 | 61.3 | 12.4 | 20 | 12.0 | 63 | 24 | 16 | 11.0 | 55.0 | 38.9 |
| Alkalinity | (mg/L) | 10 | 67 | 203 | 153 | 20 | 2.5 | 440 | 228 | 16 | 100 | 440 | 273 |
| Bicarbonate | (mg/L) | 10 | 82 | 248 | 186 | 20 | 3.0 | 536 | 277 | 16 | 122 | 536 | 333 |
| Sodium | (mg/L) | 10 | 17 | 57 | 34 | 20 | 18.0 | 92.6 | 50.9 | 16 | 16.0 | 85.0 | 58.2 |
| Potassium | (mg/L) | 10 | 3.3 | 28 | 7.3 | 20 | 2.4 | 21 | 10 | 16 | 4.40 | 35.00 | 16.61 |
| Calcium | (mg/L) | 10 | 15.0 | 75 | 42 | 20 | 15.0 | 88 | 53 | 16 | 26.0 | 100.0 | 74.1 |
| **Dissolved Metals/Semimetals** | | | | | | | | | | | | | |
| Antimony | (mg/L) | 10 | 0.0025 | 0.025 | 0.006 | 20 | 0.0020 | 0.025 | 0.008 | 16 | <0.019 | <0.019 | * |
| Arsenic, Total | (mg/L) | 10 | 0.002 | 0.170 | 0.023 | 20 | 0.003 | 0.21 | 0.022 | 16 | 0.005 | 0.410 | 0.027 |
| Boron | (mg/L) | 10 | 0.05 | 0.60 | 0.12 | 20 | 0.05 | 0.84 | 0.31 | 16 | 0.091 | 1.080 | 0.685 |
| Iron | (mg/L) | 10 | 0.005 | 100 | 2.8 | 20 | | 59 | 1.7 | 16 | 0.010 | 220 | 1.558 |
| Lead | (mg/L) | 10 | 0.025 | 0.025 | 0.02 | 20 | 0.025 | 0.025 | 0.025 | 16 | 0.001 | 0.310 | 0.018 |
| Magnesium | (mg/L) | 10 | 3.7 | 35 | 12 | 20 | 5.8 | 30 | 13 | 16 | 10.0 | 48.0 | 21.0 |
| Manganese | (mg/L) | 10 | 0.001 | 2.8 | 0.1 | 20 | | 2.9 | 0.1 | 16 | 0.005 | 2.000 | 0.036 |
| Mercury | (mg/L) | 10 | 0.0001 | 0.0002 | 0.0001 | 20 | 0.00005 | 0.00015 | 0.00007 | 16 | 0.00010 | 0.00500 | 0.00052 |
| Selenium | (mg/L) | 10 | 0.0025 | 0.05 | 0.01 | 20 | 0.0025 | 0.05 | 0.01 | 16 | 0.001 | 0.007 | 0.004 |
| Thallium | (mg/L) | 10 | 0.001 | 0.0025 | 0.001 | 20 | 0.0025 | 0.025 | 0.01 | 16 | 0.011 | 0.210 | 0.107 |
| Zinc | (mg/L) | 10 | 0.0025 | 0.042 | 0.01 | 20 | 0.0025 | 0.071 | 0.02 | 16 | 0.003 | 2.200 | 0.031 |

## Table 3.2-7 (Continued)
## Summary of Ground Water Chemistry by Hydrostratigraphic Unit

| Constituent | Units | Intrusive[2] | | | | Marine Clastic[2] | | | | Marine Carbonate[2] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number of Wells | Minimum | Maximum | Average | Number of Wells | Minimum | Maximum | Average | Number of Wells | Minimum | Maximum | Average |
| **Physical and Aggregate Properties** | | | | | | | | | | | | | |
| TDS | (mg/L) | 7 | 270 | 510 | 392 | 13 | 185 | 450 | 305 | 24 | 310 | 672 | 566.2 |
| **Inorganic Nonmetallic Constituents** | | | | | | | | | | | | | |
| Chloride | (mg/L) | 7 | 4.0 | 81.0 | 46.3 | 13 | 3.4 | 69.0 | 17.0 | 24 | 3.0 | 19 | 14.9 |
| Fluoride | (mg/L) | 7 | 0.21 | 0.90 | 0.47 | 13 | 0.36 | 0.70 | 0.50 | 24 | 0.6 | 1.6 | 1.3 |
| pH | (pH units) | 7 | 6.3 | 8.9 | 8.0 | 13 | 6.4 | 9.2 | 7.6 | 24 | 5.1 | 8 | 6.7 |
| Sulfate | (mg/L) | 7 | 45.0 | 190.0 | 134.1 | 13 | 43.0 | 190.0 | 80.4 | 24 | 48.0 | 160 | 77.0 |
| Temperature | (degrees C) | 7 | 11.0 | 35.0 | 21.1 | 13 | 11.0 | 40.0 | 23.5 | 24 | 29.0 | 60 | 51.3 |
| Alkalinity | (mg/L) | 7 | 75 | 170 | 127 | 13 | 100.0 | 180 | 140 | 24 | 160.0 | 480 | 422.0 |
| Bicarbonate | (mg/L) | 7 | 91 | 207 | 155 | 13 | 122 | 219 | 171 | 24 | 195.1 | 585.216 | 514.5 |
| Sodium | (mg/L) | 7 | 20.0 | 44.0 | 30.7 | 13 | 15.8 | 36.0 | 23.6 | 24 | 21.0 | 85.5 | 73.9 |
| Potassium | (mg/L) | 7 | 2.60 | 8.10 | 5.51 | 13 | 4.40 | 8.90 | 6.35 | 24 | 6.6 | 25 | 20.9 |
| Calcium | (mg/L) | 7 | 32.0 | 80.0 | 51.8 | 13 | 28.0 | 57.0 | 38.7 | 24 | 39.0 | 109 | 88.9 |
| **Dissolved Metals/Semimetals** | | | | | | | | | | | | | |
| Antimony | (mg/L) | 7 | 0.039 | 0.039 | 0.039 | 13 | <0.019 | <0.019 | * | 24 | 0.022 | 0.050 | 0.035 |
| Arsenic, Total | (mg/L) | 7 | 0.020 | 0.200 | 0.095 | 13 | 0.002 | 0.570 | 0.113 | 24 | 0.008 | 0.451 | 0.021 |
| Boron | (mg/L) | 7 | 0.084 | 0.100 | 0.094 | 13 | 0.047 | 0.107 | 0.094 | 24 | 0.600 | 0.847 | 0.767 |
| Iron | (mg/L) | 7 | 0.020 | 4.300 | 0.463 | 13 | 0.020 | 3.400 | 0.468 | 24 | 0.030 | 14.7 | 0.308 |
| Lead | (mg/L) | 7 | 0.001 | 0.012 | 0.007 | 13 | 0.001 | 0.007 | 0.004 | 24 | <0.001 | 0.012 | 0.007 |
| Magnesium | (mg/L) | 7 | 12.0 | 38.0 | 25.5 | 13 | 11.0 | 37.2 | 20.3 | 24 | 19.0 | 32.0 | 21.9 |
| Manganese | (mg/L) | 7 | 0.002 | 1.200 | 0.114 | 13 | 0.005 | 0.342 | 0.083 | 24 | 0.007 | 0.092 | 0.013 |
| Mercury | (mg/L) | 7 | 0.0001 | 0.0001 | 0.000 | 13 | 0.00010 | 0.00028 | 0.00019 | 24 | 0.0001 | 0.00222 | 0.0007 |
| Selenium | (mg/L) | 7 | 0.006 | 0.013 | 0.010 | 13 | 0.001 | 0.001 | 0.001 | 24 | 0.002 | 0.004 | 0.004 |
| Thallium | (mg/L) | 7 | 0.002 | 0.002 | 0.002 | 13 | <0.001 | <0.001 | * | 24 | <0.001 | <0.001 | * |
| Zinc | (mg/L) | 7 | 0.005 | 0.069 | 0.017 | 13 | 0.005 | 0.100 | 0.026 | 24 | 0.002 | 0.180 | 0.017 |

Source:

[1] Barrick 1998h.

[2] Radian International, LLC and Baker Consultants, Inc. 1997b.

[3] Average below detection limit.

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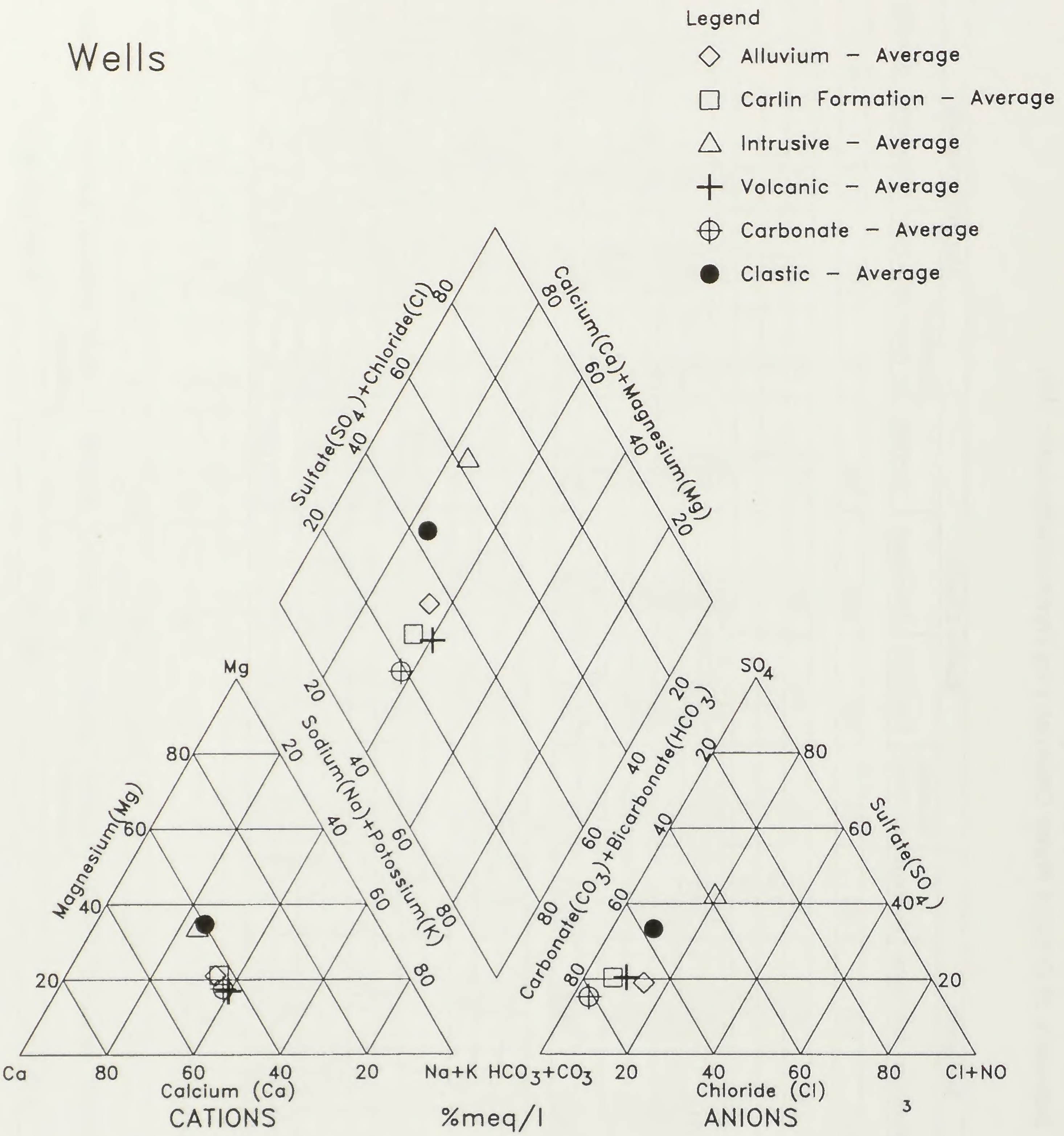

Figure 3.2-13

Piper Trilinear Diagram of Baseline Ground Water Chemistry water in each of the six major hydrostratigraphic units in the hydrologic study area.

Marine Clastic Rocks. The marine clastic rocks near the Betze-Post Pit primarily contain a calcium-magnesium-bicarbonate-type water with elevated concentrations of sulfate and silica. The average pH of these waters is 7.6, and the average total dissolved solids (TDS) concentration is 305 milligrams per liter (mg/L) (Radian International, LLC and Baker Consultants, Inc. 1997b). These water chemistry characteristics also generally apply to ground water sampled from marine clastic rocks located within several miles of the mine.

Marine Carbonate Rocks. Ground water sampled from the marine carbonate rocks near the Betze-Post Pit is a strong calcium-bicarbonate-type water that contains less sodium and sulfate. The pH of these waters averages 6.7 to 6.8, and the TDS concentration averages 566 mg/L (Radian International, LLC and Baker Consultants, Inc. 1997b). However, NA-15, which is located several miles upgradient of the pit, has a pH of 8.2 and a TDS concentration of 280 mg/L.

Intrusive Rocks. The intrusive rocks near the Betze-Post Pit generally contain a calcium-sulfate-type ground water with elevated concentrations of chloride and lower concentrations of potassium and silica. The pH of these waters averages 8.0, and the average TDS concentration is approximately 392 mg/L (Radian International, LLC and Baker Consultants, Inc. 1997b).

Volcanic Rocks. Ground water sampled from volcanic rocks in the study area is generally a bicarbonate-type water with no dominant cations. Calcium and sodium are present in approximately equal proportions with smaller amounts of potassium and magnesium. The pH averages 7.7, and the average TDS concentration is approximately 375 mg/L. These characteristics are based on the evaluation of chemical analyses from 20 wells completed in volcanic rocks.

Carlin Formation. Ground water sampled from the Carlin Formation near the pit is generally a calcium-bicarbonate-type water with smaller amounts of sodium, silica, and sulfate. These waters have an average pH of 7.4 and an average concentration of TDS of approximately 478 mg/L (Radian International, LLC and Baker Consultants, Inc. 1997b).

Alluvium. Based on samples from 10 wells, the alluvium in the study area contains a bicarbonate-type water with no dominant cations. There are approximately equal amounts of calcium and sodium and smaller amounts of potassium and magnesium. The pH of ground water in the alluvium averages 7.6, and the TDS concentration averages 330 mg/L.

**Betze-Post Pit Area.** Overall, the ground water sampled near the Betze-Post Pit can be separated into two general types based on a statistical discriminate analysis. Ground water from the marine carbonate rocks is calcium-bicarbonate enriched. The Carlin Formation and marine clastic rocks near the mine also contain calcium-bicarbonate type water, but there are also relatively higher concentrations of silica, manganese, and chloride in these waters (Radian International, LLC and Baker Consultants, Inc. 1997b).

Ground water encountered near the Betze-Post Pit generally has low concentrations of trace metals; however, arsenic, barium, boron, fluoride, iron, and manganese are commonly detected. Arsenic concentrations average 0.06 mg/L and are highest in the ground water found in marine clastic and intrusive rocks. Barium, boron, and fluoride concentrations are elevated in the thermal ground water in the marine carbonate rocks and Carlin Formation near the pit. The mean concentration of iron is highest (1.6 mg/L) in the Carlin Formation, and manganese concentrations are about an order of magnitude greater in ground water from the marine clastic rocks and intrusive rocks than from other rocks near the mine. Antimony is detected primarily in ground water from the marine carbonate rocks and intrusive rocks where it is found in concentrations that average between 0.03 and 0.04 mg/L. In approximately 5 percent of the ground water samples near the mine, chromium and copper were detected below 0.03 and 0.1 mg/L, respectively. The average concentration of zinc in ground water near the mine is approximately 0.02 mg/L. Cadmium, lead, mercury, nickel, selenium, silver, and thallium have been detected in less than 5 percent of the ground water samples near the mine and at concentrations that are generally less than 0.01 mg/L (Radian International, LLC and Baker Consultants, Inc. 1997b).

**Boulder Valley Area.** State and/or Federal drinking water standards for pH were exceeded in only 6 ground water samples (Barrick 1997e, 1998h): 1 sample out of 87 was high in alluvium, 4 out of 232 were high in volcanic rock, and 1 sample from volcanic rock had a low pH (3.5). The average pH of alluvial and volcanic rock ground water was just slightly alkaline. Drinking water standards for TDS were exceeded in 24 samples: 1 out of 85 alluvial ground water samples and 23 out of 227 ground water samples taken from wells completed in volcanic rock. However, 17 of these samples were from one well-NA-17 (Barrick 1998h).

Trace elements detected in ground water from alluvial wells include arsenic, barium, boron, copper, fluoride, iron, lead, manganese, selenium, and zinc. However, exceedences of drinking water standards were infrequent and included arsenic, iron, and manganese with maximum values of 0.14 mg/L, 100 mg/L, and 2.8 mg/L, respectively. Ground water samples taken from wells completed in volcanic rocks had trace element detections of aluminum, arsenic, barium, boron, chromium, copper, fluoride, iron, lead, manganese, selenium, thallium, and zinc. State and/or Federal drinking water standards were exceeded in at least one ground water sample from volcanic rocks for aluminum, arsenic, fluoride, iron, lead, and manganese with maximum values of 0.7 mg/L, 0.21 mg/L, 3.0 mg/L, 59 mg/L, 0.018 mg/L, and 2.9 mg/L, respectively.

**Seep and Spring Water Quality.** As described in the discussion of seeps and springs above, field inventories have been conducted to identify seeps and springs located throughout the region (JBR 1990a; RTi 1994). Field measurements of temperature, pH, and conductivity were collected at each spring identified during the seep and spring inventories. In addition, water samples were collected at representative springs as part of the seep and spring inventories (JBR 1990a; RTi 1994) to characterize the water chemistry for representative springs to determine the origin of the spring waters. The laboratory analysis included TDS, major anions and cations, metals, and (in selected springs) stable isotopes and tritium.

The measured temperature of the springs ranged from 38 to 78 degrees Fahrenheit. Since most of the springs have very small flows (less than 3 gpm), the measured temperature is strongly influenced by air temperature. No hot (greater than 90 degrees Fahrenheit) springs were identified during the inventories. The pH values for 399 of the seep and spring sites measured in the field ranged from 6.4 to 8.9. Two springs (S36-51-07L and S36-51-07M) located below an historic mine dump had acidic values of 4.0 and 3.3, respectively; four springs in the upper Antelope Creek area had pH values ranging from 9.0 to 10.3 (RTi 1994).

Excluding a few apparently anomalous springs, discharge from springs sampled had a low to moderate TDS concentration ranging from 32 to 550 (RTi 1994). Springs with the lowest TDS concentrations discharge at high elevations in the Tuscarora Mountains. The results of the trace metal analyses indicate that again, excluding a couple of anomalous springs, the concentration of metals in spring water is generally low throughout the region.

Tritium concentrations were determined in selected representative springs to distinguish the relative age of the water discharging from the ground water system. Tritium is a radioactive isotope with a half life of 12.4 years. Because of rapid decay, water that entered the subsurface (as precipitation recharge to the ground water system) pre-1954 would today contain less than 1 tritium unit (TU). In contrast, tritium concentrations in precipitation in the last few years generally range from approximately 10 to 20 TU. Concentrations of tritium in several samples from the east slope of the Tuscarora Mountains indicate that the ground water in this area has a very short residence time that probably spans no more than a few years (RTi 1994). In contrast, tritium samples from the upper Antelope Creek-Squaw Creek area and upper and lower Willow Creek area had very low tritium concentrations, indicating that these waters contain little if any post-1954 water. Several other samples collected throughout the region contained intermediate tritium concentrations that either reflect an intermediate age of the water or mixing of somewhat older water (pre-1954) with younger water (RTi 1994).

**Surface Water Quality Standards**. Surface water quality standards are established by the State of Nevada for designated beneficial uses associated with waters of the state. "Waters of the state" means all waters situated wholly or partly within or bordering upon this state, including but not limited to (1) all streams, lakes, ponds, impounding reservoirs, marshes, water courses, waterways, wells, springs, irrigation systems, and drainage systems; and (2) all bodies or accumulations of water, surface and underground, natural or artificial (Nevada Revised Statutes 445A.415). Designated beneficial uses are defined in Nevada Administrative Code 445A.122 and water quality standards applicable to the hydrologic study area are prescribed in Nevada Administrative Code 445.144 and 445A.124 through 445A.126, inclusive.

As shown in Figure 3.2-14 (Nevada Administrative Code 445.144 and 445A.124 through 445A.126), surface waters in the hydrologic study area have been classified as either Class A, B, C, or waters upstream and tributary to the Humboldt River. The purpose of the classification is to establish beneficial uses and appropriate water quality standards for stream segments. Table B-1 and Table B-2 in Appendix B list water quality standards applicable to surface waters in the hydrologic study area.

**Surface Water Quality**. Stream water quality within the hydrologic study area is monitored by Barrick on a monthly basis (Barrick Boulder Valley Monitoring Plan Reports [1991-1998]). The following streams are monitored (Figure 3.2-15) (Barrick 1999a):

| Boulder Flat | Rock Creek Valley | Maggie Creek Area |
|---|---|---|
| Bell Creek | Antelope Creek | Maggie Creek |
| Boulder Creek | Rock Creek | |
| Brush Creek | | |
| Rodeo Creek | | |

Stream water quality data have been collected as single samples during short-term intensive surveys (RTi 1994; AATA International, Inc. 1997); as single samples during arbitrarily selected times by the USGS; and as part of the Barrick monitoring program (Barrick 1999a). Only the stream water quality data collected by the USGS and data collected during the Barrick monitoring program (Barrick 1999a) were used to produce a water quality summary for each stream (see Appendix B, Table B-3). In addition, the data summaries only include data collected through 1997. Monitoring program data collected in 1998 (Barrick 1999a) were evaluated, however, and are consistent with the data summaries and interpretations presented.

The streams contained combinations of calcium, magnesium, and sodium as dominant cations, though bicarbonate was the dominant anionic water type for all streams (Barrick 1999a). Concentrations of TDS ranged from 72 mg/L in Bell Creek to 2,300 mg/L in Rodeo Creek. Values of pH were typically neutral to alkaline ranging from a low of 7.1 in Boulder and Rodeo creeks to 10.0 in Rodeo Creek (Table B-3).

Average metals concentrations were typically below applicable Nevada Standards for Toxic Materials (see Appendix B, Table B-1), but there were incidences of elevated arsenic, iron, manganese, and thallium concentrations. Concentrations that exceeded toxic materials standards are presented in bold type in Table B-3. For the constituents measured, standards were met during the sampling periods except for the following:

- Maggie Creek (thallium)
- Rock Creek (thallium, fluoride)
- Boulder Creek (fluoride, arsenic, iron, and manganese)
- Antelope Creek (fluoride)
- Bell Creek (manganese)
- Brush Creek (fluoride)
- Rodeo Creek (fluoride, arsenic, iron, and manganese)

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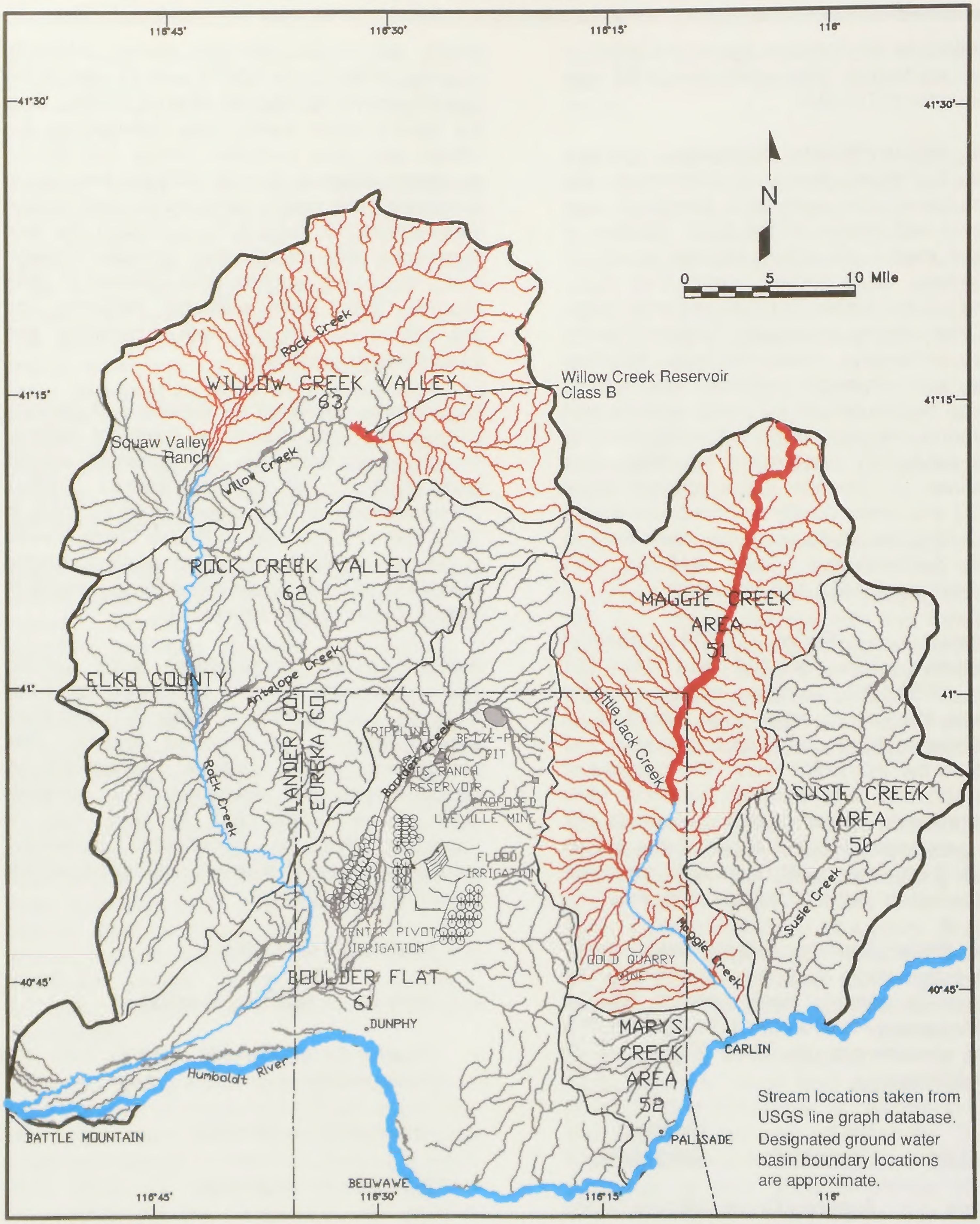


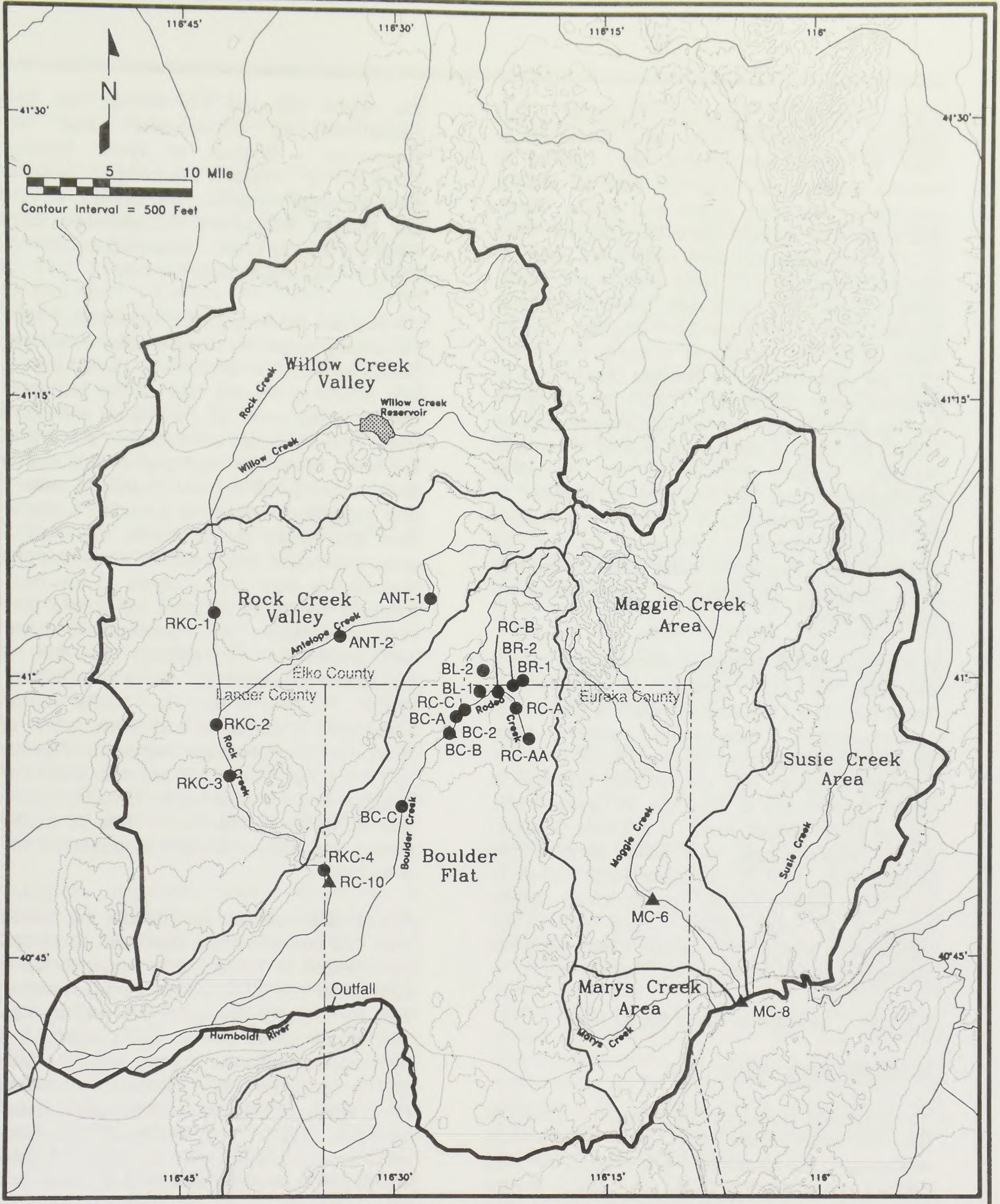
Legend

| | |
|---|---|
| ▬ | Ground Water Basin Boundary |
| —·—·— | County |
| ▬ | Streams Tributary to the Humboldt River |
| ▬ | Humboldt River |
| ▬ | Class A |
| ▬ | Class B |
| ▬ | Class C |
| ○ | Center Pivot Irrigation |

Betze Supplemental EIS

Figure 3.2-14

Stream Classification for Beneficial Uses and Associated Standards



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Study Area

Ground Water Basin Boundary

HR-1 ▲ USGS Active Stream-gaging Station ①

BC-C ● Barrick Surface Water Sampling Locations ②

① Abbreviations:
MC = Maggie Creek;
BC = Boulder Creek;
RC = Rock Creek and its tributaries

② Abbreviations:
RKC = Rock Creek; ANT = Antelope Creek;
BC = Boulder Creek; BL = Bell Creek;
BR = Brush Creek; and RC = Rodeo Creek

Figure 3.2-15

Stream Sampling Sites with Summarized Water Quality Data

Water Quality in Lahontan Cutthroat Trout Streams. A baseline study was conducted in 1997 by AATA International, Inc. (1998a) to monitor water quality and flow data for stream reaches in the Rock Creek and Willow Creek drainages that support Lahontan cutthroat trout (LCT) (*Onchorhynchus clarki henshawi*). Selected streams supporting LCT were upper Rock Creek, Nelson Creek, Toe Jam Creek, Lewis Creek, and Frazer Creek (see Figure 3.6-1 and Appendix B, Table B-4). The monitored streams supporting LCT are classified by the Nevada Department of Environmental Protection (1997) as Class A waters. According to Nevada Administrative Code 445A.124, Class A waters are located in areas of minimal human habitation, no industrial development, and no intensive agriculture. In addition, the watershed is relatively undisturbed by human activities. Nevada Division of Environmental Protection water quality standards are, therefore, protective of these relatively pristine waters.

A summary of the generated stream water quality database for LCT streams is provided in Table B-4. The LCT streams were a calcium or calcium-sodium bicarbonate water type. Streamflow ranged from less than 0.1 to 0.29 cfs. Concentrations of TDS ranged from 90 mg/L in upper Rock Creek to 150 mg/L in Lewis Creek. Values of pH ranged from 7.6 in Lewis Creek to 8.6 in Nelson Creek, and water temperatures ranged from 14.2 °C in upper Rock Creek to 23.3 °C in Nelson Creek. The dissolved oxygen standard in upper Rock Creek and water temperature standard in Nelson Creek were not met during the sampling event (Table B-4).

### 3.2.1.3 Humboldt River Study Area

#### Humboldt River Water Uses

For purposes of examining potential impacts to the Humboldt River from mine dewatering discharges, the Humboldt River study area was defined as extending from the USGS stream gage at Carlin, Nevada (10321000) to the Humboldt Sink downstream. The river study area is shown in Figure 1-6 (Basin Boundaries and Humboldt River Features).

In addition to Barrick's Goldstrike Mine data, major sources of flow and water quality data for the region included the USGS; the Nevada Department of Conservation and Natural Resources - Division of Water Resources, Division of Water Planning, Division of Environmental Protection and Division of Wildlife; the Natural Resources Conservation Service; Pershing County Water Conservation District; and the U.S. Fish and Wildlife Service.

Throughout its length, the Humboldt River has historically supported diverse water demands and beneficial uses. In addition to recreational uses and providing aquatic and wildlife habitats, the river supplies water for commerce and domestic uses. Primary water development sectors within the basin have been agricultural (irrigated crops and livestock), mining, and municipal uses. Data and projections regarding dominant uses of the river are shown by county in Appendix C. It should be noted that projected uses can change dramatically from one analysis to the next; for example, estimates of future agricultural demand and consumption vary substantially from the 1992 projections (increasing) to the 1996 projections (decreasing) (Nevada Division of Water Planning 1992a, b, 1998). Graphical summaries of demands and consumption in the Humboldt River basin are depicted in Figures C-1 and C-2 in Appendix C. These data show that the irrigation and livestock sector is by far the largest use of water in the basin. The proportion of mining and municipal uses is projected to vary over time.

Actual water use data for 1995 for the five-county area that comprises the Humboldt River basin is summarized in Table C-3 in Appendix C. These data show that 87.5 percent of water withdrawal was for irrigation/livestock use. Mining was the next largest water user at 10.7 percent, followed by municipal/industrial (1.7 percent) and domestic (0.1 percent). Elko and Humboldt counties had the majority of irrigation and livestock water use whereas Eureka and Humboldt counties had most mining-related water withdrawal. Total water withdrawn in the Humboldt River basin in 1995 was relatively evenly divided between ground water and surface water sources. In addition, approximately 50 percent of all water withdrawn in 1995 was consumed (Table C-4 in Appendix C). A considerable amount of the consumed water is due to evaporation from the ditches and reservoirs, as well as evapotranspiration by the plants that are irrigated.

Tables C-3 and C-4 in Appendix C indicate that total water withdrawal in 1995 for the five specific counties in the Humboldt River basin was approximately 2.2 million acre-feet, half of which came from ground water sources and the other half from surface water sources. Table C-4 shows that the average consumptive use in 1995 for the same five-county area was approximately 49 percent of the total water withdrawal. Total consumptive water use for both surface and ground water in 1995 for the five-county area was approximately 1.1 million acre-feet. It generally can be estimated that consumptive use of surface water was on the order of 540,000 acre-feet for the year, which is less than the decreed and permitted water usage of approximately 667,000 acre-feet per year for the Humboldt River.

It should be noted that the water demands and consumption in the counties listed are not all made directly on Humboldt River surface flows; a substantial amount of demand is met by ground water sources or surface water sources tributary to the river. However, the data generally indicate the relative magnitudes of past and projected water uses in the basin. An additional wildlife use of Humboldt River water is at wildlife management areas at the Humboldt and Carson sinks and in habitats along the river.

**Agricultural Irrigation Uses.** As shown in Appendix C, agricultural uses dominate the demands on Humboldt River flows. Table 3.2-8 illustrates an approximate seasonal distribution of the annual irrigation demands that were used to evaluate potential changes in the surface water environment of the Humboldt River from Palisade to the Comus gage. Additional published estimates were used downstream of Comus (Eakin 1962; Eakin and Lamke 1966). The general monthly irrigation demands shown in Table 3.2-8 were approximated from seasonal requirements to meet priorities as described by the Nevada Department of Conservation and Natural Resources (NDCNR) (1964). According to the NDCNR, approximately 48 percent of the annual decreed diversion occurs from March 15 through April 28, approximately 29 percent of the annual decreed diversion occurs from April 28 through June 13, and approximately 23 percent of the annual decreed diversion occurs from June 13 through September 15. Additional diversions based on older permits may occur before or after these dates.

**Irrigation Efficiency, Return Flow Pattern, and Return Location.** Irrigation return flow is the portion of diverted water that is not consumed by evapotranspiration and returns later to the stream system. The amount of water returned and the timing of its return vary in complex ways according to agricultural water management systems, the type of crop grown, and the nature of lands under irrigation. The general rate at which used irrigation water returns to the system can be expressed regionally as a percentage of the original diversions over time. Regional returns often lag the original diversions by some period of time and may extend over several months. Estimates of the overall fraction of irrigation return flow range from 20 percent (Nevada State Engineer's Office 1997) to 40 percent (NDCNR 1964) of the water diverted. For quantitative evaluations of the Humboldt River upstream of Comus, the average return flow percentage was assumed to be 30 percent.

The return flow pattern used to evaluate the changes in the surface water environment of the Humboldt River was developed from a Glover analysis (Glover 1978). The Glover parameters assumed in determining the return flow pattern are believed to be applicable to the irrigated areas along the Humboldt River (hydraulic conductivity = 10 feet/day, voids ratio = 0.20, and distance to stream = 1,000 to 5,000 feet). Based on the Glover analysis, the fraction of irrigation water returning to the stream system was assumed to return over a 5-month period. As a percentage of the total return flow, it is assumed that approximately 75 percent of the return flow would occur in the first month after diversion, 17 percent in the second month, 5 percent in the third month, 2 percent in the fourth month, and 1 percent in the fifth month.

It is assumed for purposes of the impact analyses that the return flow quantities are represented in the USGS gage data. It also is assumed that return flows for the reach between Palisade and Battle Mountain are reflected in the Battle Mountain gage data, that return flows between Battle Mountain and Comus are reflected in the

### Table 3.2-8
### General Seasonal Irrigation Demand Estimates
### (acre-feet)

| Reach | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Palisade to Battle Mountain | 0 | 0 | 8,572 | 17,145 | 11,357 | 8,133 | 5,666 | 5,666 | 3,461 | 0 | 0 | 0 | 60,000 |
| Battle Mountain to Comus | 0 | 0 | 5,165 | 10,329 | 6,287 | 4,322 | 2,358 | 2,360 | 1,179 | 0 | 0 | 0 | 32,000 |

Comus gage data, and so on downstream. Again, without an in-depth analysis of specific diversions and irrigation practices, this represents a reasonable assumption for subsequent impact analysis.

**The Humboldt Project and Pitt-Taylor Reservoirs.** Water from the Humboldt Project is used to irrigate approximately 40,000 acres, mostly in hay, in the Lovelock Valley. Operation and maintenance of the Humboldt Project, which consists of Rye Patch Dam, Rye Patch Reservoir, and associated outlets and conveyances, are conducted by the Pershing County Water Conservation District. Return flows from irrigation are directed to the Humboldt Sink area (Toulon Lake or Humboldt Lake) immediately downstream of the Lovelock Valley via agricultural drains.

Rye Patch Reservoir and the Pitt-Taylor reservoirs are the largest surface water impoundments on the Humboldt River (Figure 3.2-16). They are located between Winnemucca and Lovelock approximately 100 miles downstream of the Barrick Goldstrike property. Rye Patch Dam is located on the river, and was completed in the mid-1930s. Rye Patch Reservoir can control approximately 194,300 acre-feet of water storage (USGS 1998a). It is generally an elongated narrow reservoir, somewhat wider and shallower at the upstream end. When full, its surface area is approximately 11,200 acres (17.5 square miles).

The Pitt-Taylor reservoirs (lower and upper) provide relatively shallow off-channel storage of water diverted from the river via the Pitt-Taylor Canal. These features are owned by the Pershing County Water Conservation District, and are not part of the federal Humboldt Project. A long dam on higher ground separates these reservoirs from Rye Patch Reservoir. Depending on storage, the total surface area of the Pitt-Taylor reservoirs may be up to approximately 4,600 acres (7.2 square miles). Evaporative losses from Rye Patch and Pitt-Taylor reservoirs are generally estimated at 20,000 acre-feet/year (Eakin 1962).

**Municipal and Other Water Uses.** Water use estimates for the 1990-2020 period by other demand sectors in the five-county area of the Humboldt River basin are presented in Table C-5 in Appendix C. Total water use projected for municipal water suppliers in this period ranges from approximately 12,000 to 26,000 acre-feet/year. Much of the water used in the basin originates from ground water sources, as shown in Appendix C, Table C-4. Most municipal water use in the basin is by the City of Elko (6,000 to 15,000 acre-feet/year for the period 1990-2020). Currently available water supplies for the communities included in Table C-5 is expected to be adequate beyond the year 2020. Another water user in the Humboldt River basin is the Valmy Power Station, which consumes approximately 5,000 acre-feet/year, some of which is supplied by wells and by excess water from the Lone Tree Mine dewatering system. Active National Pollutant Discharge Elimination System (NPDES) permits for Elko, Eureka, Humboldt, Lander, and Pershing counties are presented in Table C-6 in Appendix C. A total of six discharges are permitted, four of which go to the Humboldt River. All of the Humboldt River discharges are from mining operations (Goldstrike, Lone Tree, and Gold Quarry). Total permitted discharge from these mines is approximately 300 cfs or 217,000 acre-feet/year (Table C-6). The remaining two permitted discharges are from the town of Lovelock (this waste water goes to Toulon Lake) and the Nevada Division of Wildlife's Gallagher Fish

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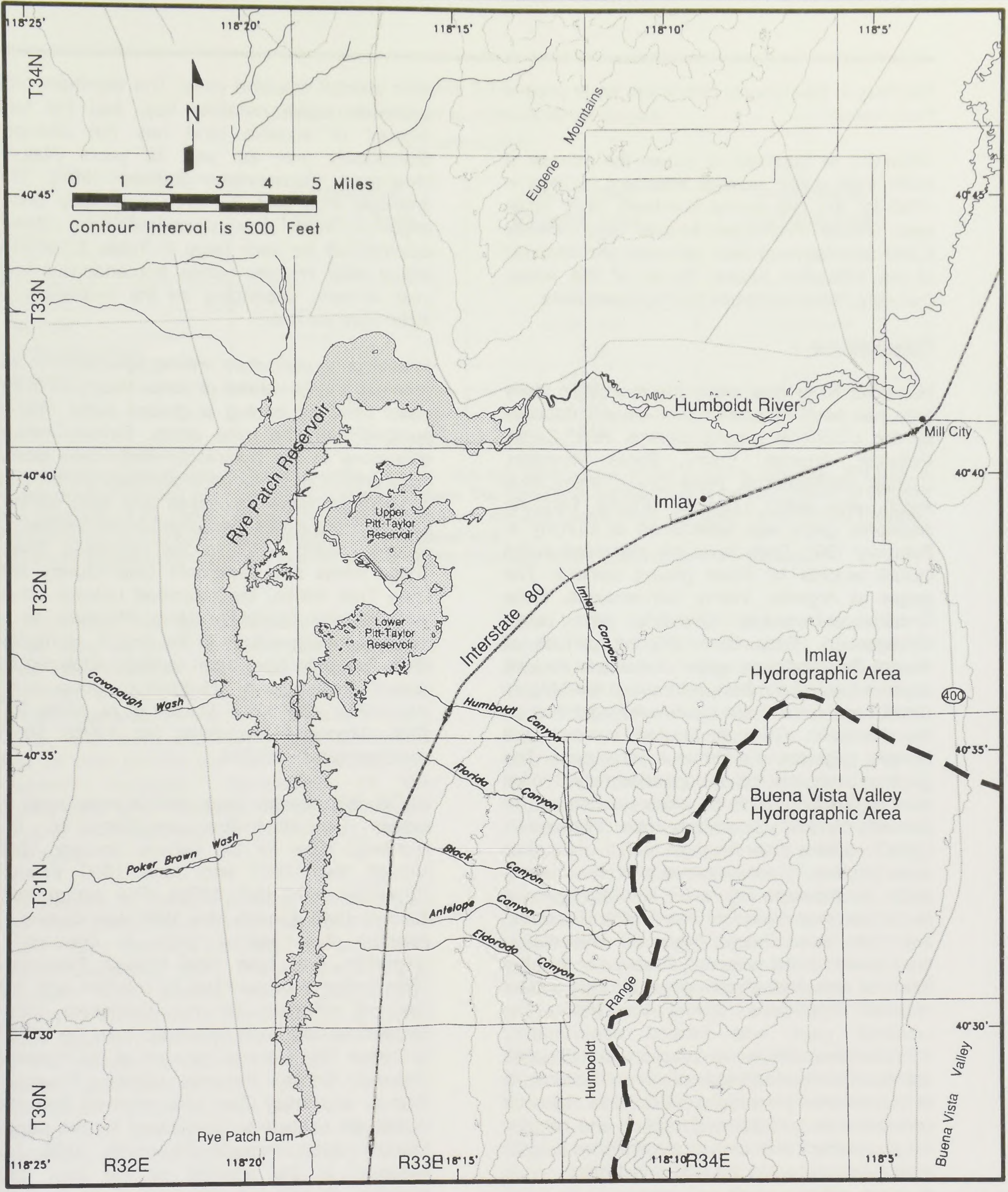


Legend

| | |
|---|---|
| ┈┈┈ | Roads |
| ▬▬▬ | Interstate 80 |
| ─── | River or Stream |
| ▬ ▬ ▬ | Hydrographic Sub-Area Boundary |

Figure 3.2-16

Rye Patch and Pitt-Taylor Reservoirs

Hatchery in Elko County (this waste water goes to Ruby Marsh).

Table C-7 in Appendix C shows the release of water from public sewage treatment facilities in 1990 for the five-county Humboldt River basin area. These discharges totalled approximately 6,200 acre-feet/year and generally are disposed of via infiltration basins. Some of this water, therefore, likely recharges the Humboldt River.

### Flow Regime

Humboldt River flow within the hydrologic study area has been measured over several decades by the USGS at gaging stations near Carlin, Palisade, Argenta, Valmy, Battle Mountain, Comus, Winnemucca, Rose Creek, Imlay, Rye Patch, and below Lovelock (Figure 1-6). An additional gage was established at Dunphy in February 1991. Daily flows are presented in the USGS records for these gaging stations. The gages at Argenta, Valmy, Winnemucca, Rose Creek, and below Lovelock have been discontinued. They have differing periods of record. The upstream gage at Carlin is located approximately 5.5 miles upstream of the Maggie Creek confluence. Barrick's dewatering outfall on the Humboldt River is located between the Dunphy gage and the former Argenta gage. The gage at Comus is located approximately 9 miles east of Golconda and 50 miles downstream of Barrick's outfall. Discharges from Newmont's Lone Tree Mine enter the main branch of the river approximately 1 mile upstream of the Comus gage. As shown on Figure 1-6, the Imlay gage is immediately upstream of Rye Patch Reservoir, and the Rye Patch gage is immediately downstream of the reservoir. Because of this, the flows at the Rye Patch gage strongly reflect reservoir operations. During the 1950s, the Lovelock gage was located approximately 10 miles downstream of Lovelock and 8 miles upstream of Humboldt Lake. Flow measurements at that location were highly affected by reservoir operations and irrigation diversions and returns. Gaging below Lovelock was discontinued in 1959 and re-established by the USGS in 1998.

Cultivated lands and water management structures lie along the Humboldt River main stem and its tributaries, except where narrow canyons, deep channel networks, or unsuitable soils prohibit cropland uses. The dominant crop grown is native meadow hay, and the total amount of irrigable land has not changed dramatically over the past 40 years (Natural Resources Conservation Service 1997). The drainage area and the area potentially under irrigation from river diversions are shown cumulatively for each gage in Table 3.2-9. The actual area irrigated varies tremendously from year to year, depending on the availability of water from the river.

In addition to agriculture, mining operations in the area use a large volume of water. Nearly all of the water used for mining is ground water that is pumped from the mine areas. Several mining operations in the hydrologic study area pump more ground water for mine dewatering than they can use for mine processes and dust control. Four of these mines discharge (or will discharge) excess ground water to the Humboldt River. These mines are Newmont's Gold Quarry and Lone Tree mines, the proposed Leeville Mine, and Barrick's Goldstrike Mine. Primarily as a result of mining activity in the region, Humboldt River flow data have been recently analyzed by several investigators (Hydrologic Consultants, Inc. 1997a; JBR 1997; Maurer et al. 1996; RTi 1998; Simons & Associates, Inc. 1995b, 1997; and Zimmerman 1992b).

USGS daily stream gage records were used to assess the streamflow conditions on the Humboldt River for the periods January 1946 through May 1990 and June 1990 through December 1996 (RTi 1998). The period from January 1946 through May 1990 was chosen to establish the baseline (prior to dewatering) conditions. The June 1990 through December 1996 period was selected to coincide with the start of pumping for the Goldstrike Mine. Streamflow data were requested from the USGS in Carson City, Nevada, for each of the following stations: Carlin, Palisade, Battle Mountain, Comus, and Imlay. The data received from the USGS are considered provisional for the period October 1994 through December 1996 but remained in the analysis as the best data available. Provisional data have been finalized and additional data have become available since the time of the original streamflow data analysis (RTi 1998). These data show substantially higher streamflow averages for recent years (1991

### Table 3.2-9
### Areas Upstream of Humboldt River Gages
### (square miles)

| Gage | Cumulative Drainage Area | Cumulative Irrigated Area[1] | Incremental Irrigated Area[1] |
|---|---|---|---|
| Carlin | 4,310 | 223 | |
| Palisade | 5,010 | 231 | 8 |
| Dunphy | 7,470 | unknown | unknown |
| Argenta | 7,490 | unknown | unknown |
| Battle Mountain | 8,870 | 303 | 72 |
| Comus | 12,100 | >322[2] | >19 |
| Imlay | 15,700 | >345 | 23 |
| Lovelock | 16,600 | >448 | 103 |

Source: USGS 1998a.

[1] Incremental irrigated area is the area under irrigation from one stream gage to the next. For example, there are 8 square miles of irrigated lands between Carlin and Palisade. The cumulative irrigated area is the total amount of irrigated land upstream of the gage. For example, above Carlin there are 223 square miles of irrigated land. Above Palisade, there are 223 + 8 = 231 cumulative square miles of irrigated land.

[2] Additional irrigated lands beyond those recorded under the Humboldt River Decree occur in this subarea.

through 1998) than are depicted in the following tables due, in part, to precipitation increases since 1995. However, the essential points of the tables are still pertinent to the discussion: that a drought occurred in the late 1980s and early 1990s, and more importantly, that streamflow data for short periods can vary dramatically from long-term averages. Comparison of the hydrographs also indicates that peak flows are reduced from upstream to downstream on the river system.

The stations at Carlin, Palisade, Comus, Imlay, and Rye Patch have continuous data for the entire study period, including January 1946 through December 1996. The stations at Battle Mountain and Argenta have discontinuous records for the period of interest. Missing data at Battle Mountain and Argenta were synthesized for the periods of interest (through 1996) by means of statistical correlation with the gage data from Carlin, which showed the best fit with existing data. This approach yielded regression coefficients of 0.90 or above for most months.

The station at Dunphy has no historical record prior to mine dewatering, but does have data during the recent period of mine discharges to the Humboldt River. This makes it useful for comparisons to recent river conditions in the outfall locale, but it does not have the period of record for long-term historical or regional analysis. Substantial irrigation withdrawals as well as channel losses and gains occur in the reach from Comus to Imlay, and from Rye Patch Reservoir to the Humboldt Sink. These lower reaches were examined qualitatively. The gage at Rye Patch was not used for river flow analysis because it is downstream of Rye Patch Reservoir and is highly influenced by reservoir storage and operation. The gage data for Valmy, Winnemucca, Rose Creek, and Lovelock were not incorporated into the quantitative flow analysis due to their relatively short periods of record and because they were discontinued several decades prior to this assessment. Average annual flow hydrographs for the selected stations are shown in Figure 3.2-17 (RTi 1998).

Except for its lower reaches near Lovelock, the Humboldt River is generally perennial throughout its length within the study area. Flows are highly variable and nearly cease during some low-flow periods. High flows in the river typically occur during the months of April, May, and June as a result of snowmelt; low flows usually occur in August, September, and October. Low flow is defined herein as streamflow during the period when minimal effects from man-made diversions and return flows, storm and snowmelt runoff, and evapotranspiration occur. Low flows for this study have been assessed as flow conditions in September, when irrigation diversions and evapotranspiration are still occurring.

The average flow on a yearly basis for January 1946 through May 1990 and June 1990 through December 1996 is summarized for the selected long-term Humboldt River gages in Table 3.2-10. Further data summaries for the gages are shown for the pre-pumping period (1946-1990) in Appendix C, Table C-8.

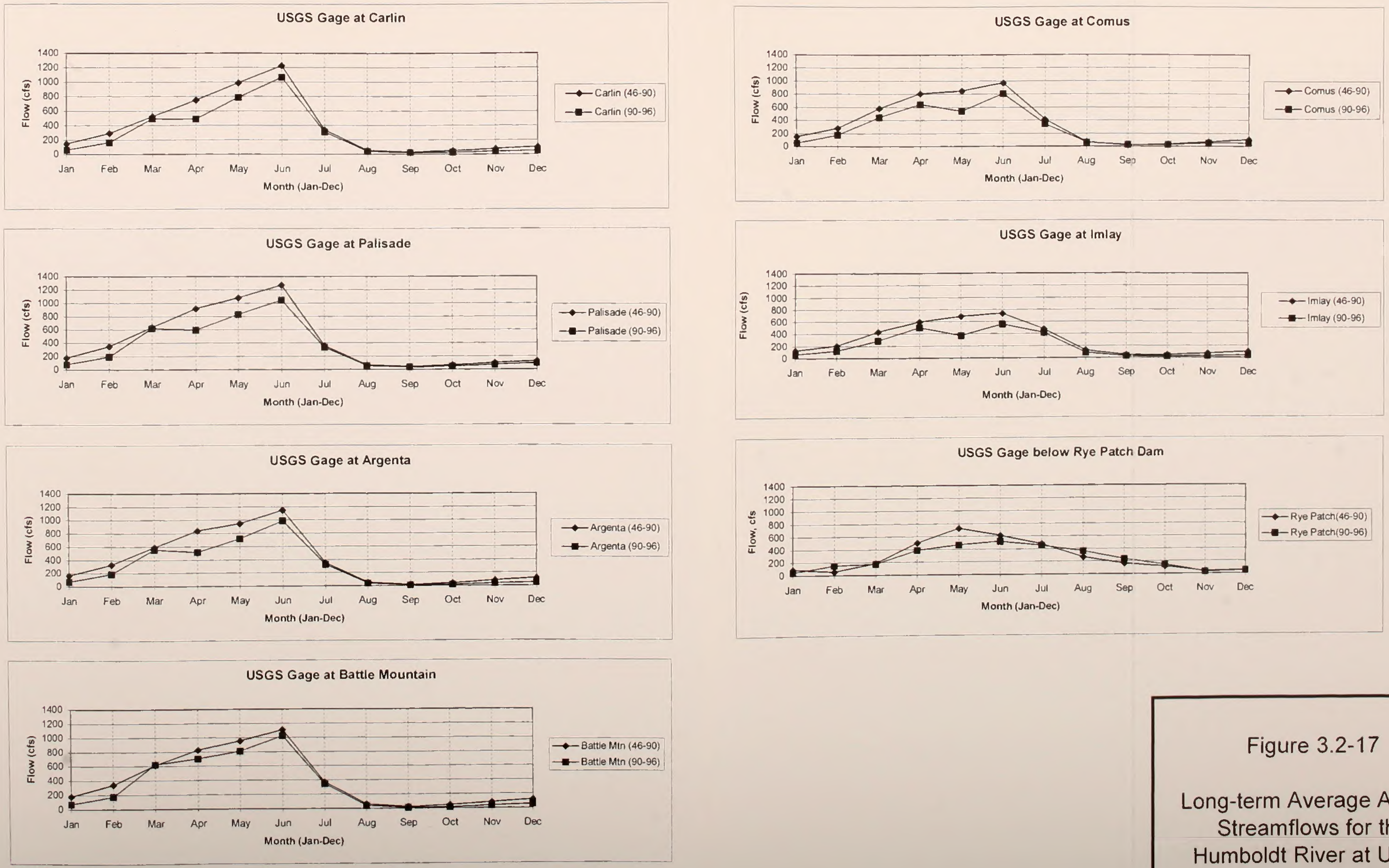
USGS records (and annual hydrographs developed from them) indicate that the highest flows on the river typically occur during June. Average high flows for the peak runoff month (June) for the periods from January 1946 through May 1990, and for June 1990 through December 1996, are summarized in Table 3.2-11. Average low flows for the month of September are shown in Table 3.2-12 for the two periods of interest.

It is important to note that the previous tables and discussions of flow conditions are based on averages representing a historical period of approximately 50 years. It is also important to note that wide variations in precipitation and snowfall occur in time and space throughout the region. As a result, wide variations in natural streamflows also occur, and these are masked by presenting data averages for the purposes of a general discussion. For example, from Table 3.2-11 the average peak flow (June flow) at Argenta from 1946 to mid-1990 is 1,146 cfs; the standard deviation for the same month over the same period is 1,037 cfs (RTi 1998). A standard deviation is a statistical characteristic that summarizes how much the data values vary from their average. These particular values indicate a very high level of variation. From Table 3.2-12, the average low flow (September flow) at Argenta is 16 cfs; the standard deviation for this is 27 cfs. At Palisade, the average June flow is 1,270 cfs, and the standard deviation is 1,007 cfs (RTi 1998). Also at Palisade, the average low flow is 41 cfs, and the standard deviation is 37 cfs (RTi 1998).

As another illustration, over the long term, peak monthly flows on the river typically occur in June. That is, the highest flow over 1 month predominantly occurs in June. However, it also should be noted that high flows, sometimes as high or higher than June flows, occasionally occur in other months such as March, April, or May. For example, 1979 was an average flow year at Argenta. The average flow for the month of June that year was 1,006 cfs. For May, it was higher - 1,129 cfs. For March, the average flow was 995 cfs - 1 percent less than June. Peak daily flow for June of that year was 2,050 cfs on June 1. The same daily flow occurred on May 31. In addition, 1,660 cfs occurred on March 12; 1,760 cfs occurred on February 16; and the highest daily flow all year was 2,350 cfs on January 14. Four days earlier the river carried 87 cfs.

Average monthly flows on the river are exceeded between 20 and 40 percent of the time. In June at Argenta, for example, the average monthly flow is 1,146 cfs for the period 1946 through mid-1990. June flows were higher than that in approximately 39 percent of those years. The average June flow in those exceeding years was approximately 2,000 cfs. September flows average 16 cfs at Argenta during the same period; this was exceeded in 22 percent of the years. The average September flow in those exceeding years was approximately 54 cfs. Similarly, substantially lower than average flows also occur much of the time. Clearly, wide variations in flow occur on the river through time. The average values presented herein are included as a means of generally depicting the flow conditions on the river, and to aid in a conceptual understanding of conditions as the river traverses the study area. Table 3.2-13 presents the estimated average annual gains and losses for the periods of interest at each of the selected Humboldt River gages. Long-term gains and losses are determined by comparing the average annual flows between successive stream gages.

As can be seen in Table 3.2-13, the river reach from Carlin to Palisade is a gaining reach on an annual basis. This is primarily due to additional runoff as well as ground water discharge into the channel from the alluvial and bedrock aquifers along the reach. In contrast, data indicate that on an annual basis the river has losing reaches historically from Palisade to Argenta and from Battle Mountain to Comus. Water loss along these reaches is due to agricultural withdrawals,



USGS Gage at Carlin

USGS Gage at Comus

USGS Gage at Palisade

USGS Gage at Imlay

USGS Gage at Argenta

USGS Gage below Rye Patch Dam

USGS Gage at Battle Mountain

Figure 3.2-17

Long-term Average Annual Streamflows for the Humboldt River at USGS Gage Stations

## Table 3.2-10
## Average Annual Humboldt River Flows (cfs)

| January 1946 - May 1990 | | June 1990 - December 1996 | |
|---|---|---|---|
| **Gage** | **Flow** | **Flow** | **Percent of 1946 - 1990 Flow** |
| Carlin | 383 | 269 | 70 |
| Palisade | 434 | 345 | 79 |
| Argenta | 391 | 262 | 67 |
| Battle Mountain | 395 | 279 | 71 |
| Comus | 365 | 232 | 64 |
| Imlay | 305 | 174 | 57 |

## Table 3.2-11
## Average June Humboldt River Flows (cfs)

| Gage | January 1946 - May 1990 | June 1990 - December 1996 | |
|---|---|---|---|
| | **Flow** | **Flow** | **Percent of 1946 - 1990 Flow** |
| Carlin | 1,228 | 1,064 | 87 |
| Palisade | 1,270 | 1,046 | 82 |
| Argenta | 1,146 | 988 | 86 |
| Battle Mountain | 1,108 | 1,023 | 92 |
| Comus | 970 | 808 | 83 |
| Imlay | 732 | 555 | 76 |

## Table 3.2-12
## Average September Humboldt River Flows (cfs)

| Gage | January 1946 – May 1990 | June 1990 - December 1996 | |
|---|---|---|---|
| | **Flow** | **Flow** | **Percent of 1946 - 1990 Flow** |
| Carlin | 27 | 20 | 74 |
| Palisade | 41 | 37 | 90 |
| Argenta | 16 | 10 | 63 |
| Battle Mountain | 23 | 11 | 48 |
| Comus | 17 | 27[1] | 159 |
| Imlay | 48 | 23 | 48 |

[1] The June 1990 through December 1996 flows at Comus may have been affected by dewatering discharges from Newmont's Lone Tree Mine, and therefore are not particularly representative of a natural occurrence.

Table 3.2-13

Mean Annual Humboldt River Gains and Losses (cfs)

| River Reach | January 1946 - May 1990<br>Flows | June 1990 - December 1996<br>Flows |
|---|---|---|
| Carlin to Palisade | +51 | +76 |
| Palisade to Argenta | -43 | -83 |
| Argenta to Battle Mountain | +4 | +17 |
| Battle Mountain to Comus | -30 | -47 |
| Comus to Imlay | -60 | -58 |

Source: RTi 1998.

evapotranspiration, and infiltration into the alluvial aquifer. Between Argenta and Battle Mountain, the river historically shows no major net gain or loss on an annual basis. Maurer et al. (1996) generally concur with these results, finding that the river gains flow from Carlin to Palisade and dominantly loses flow from Palisade to Battle Mountain.

Baseflow gains and losses have been estimated between selected Humboldt River gages by Zimmerman (1992b). Using October flows, Zimmerman indicates that a gaining reach occurs between Carlin and Palisade, such that baseflows at Palisade are approximately 19 cfs greater than flows at Carlin. This is consistent with Maurer et al. (1996). Between Palisade and Argenta, the river loses approximately 22 cfs. From Argenta to Battle Mountain, a slight gain occurs. From Battle Mountain to Comus, the river loses baseflows of approximately 10 cfs.

Similar values are shown for the periods of record identified in Table 3.2-14. The two periods used reflect similar values upstream of Argenta. Downstream of Argenta, the differences in the data may be partially caused by the effects of statistical streamflow data synthesis used for impact analyses, but are more likely due to increasing irrigated area and other discharge factors, which vary from year to year in the basin.

Maurer et al. (1996) used gage data from October 1946 through September 1981 to conduct flow duration analyses for the Humboldt River at Carlin, Palisade, Argenta, and Battle Mountain. The Battle Mountain gage was used for similar calculations by Simons (Simons & Associates, Inc. 1995b). The results of these analyses indicate that a flow of approximately 1,000 cfs is equaled or exceeded only 10 percent of the time. Similarly, a flow of approximately 2,800 cfs is equaled or exceeded only 1 percent of the time. The median flow is approximately 120 cfs, indicating that flows are greater than this half of the time, and less than this half of the time. By examining the results in Maurer et al. (1996), it can reasonably be assumed that these results closely fit the Argenta data as well, except for the lowest flows (less than 1 or 2 cfs).

In Table 3.2-13, it can be seen that substantial flow losses are typical downstream of Battle Mountain. Downstream of the Comus gage, substantial losses in river flows also occurred in a majority of the years specifically investigated in USGS studies. Between the Comus gage and the Pershing County line (see Figure 1-6), the average annual loss was 17,000 acre-feet for the period 1949-1962 (Cohen 1964). Spring and summer losses were higher than the annual average due to irrigation withdrawals, seepage to ground water, and evapotranspiration. Flow losses in the river for February though June averaged 28,000 acre-feet between Comus and the Pershing County line. Flows increased somewhat in the river from July through January as a result of irrigation returns and ground water contributions. Downstream of the Pershing County line to the Imlay gage (see Figure 1-6), approximately 5,000 acre-feet/year were lost from the river during the period 1951-1962 (Eakin 1962). Flow losses or gains varied widely in individual years for both of the reaches described above, but it can be seen that on the order of 22,000 acre-feet/year were lost between the Comus gage and the upstream end of Rye Patch Reservoir. With an additional 20,000 acre-

Table 3.2-14
Mean October Gains and Losses in the Humboldt River (cfs)

| River Reach | January 1946 - May 1990<br>Mean October Flows | June 1990 - December 1996<br>Mean October Flows |
|---|---|---|
| Carlin to Palisade | 18.4 | +20.6 |
| Palisade to Argenta | 29.7 | -30.1 |
| Argenta to Battle Mountain | 5.1 | 1.2 |
| Battle Mountain to Comus | 9.7 | 12.3 |
| Comus to Imlay | 14.4 | 4.5 |

Source: RTi 1998.

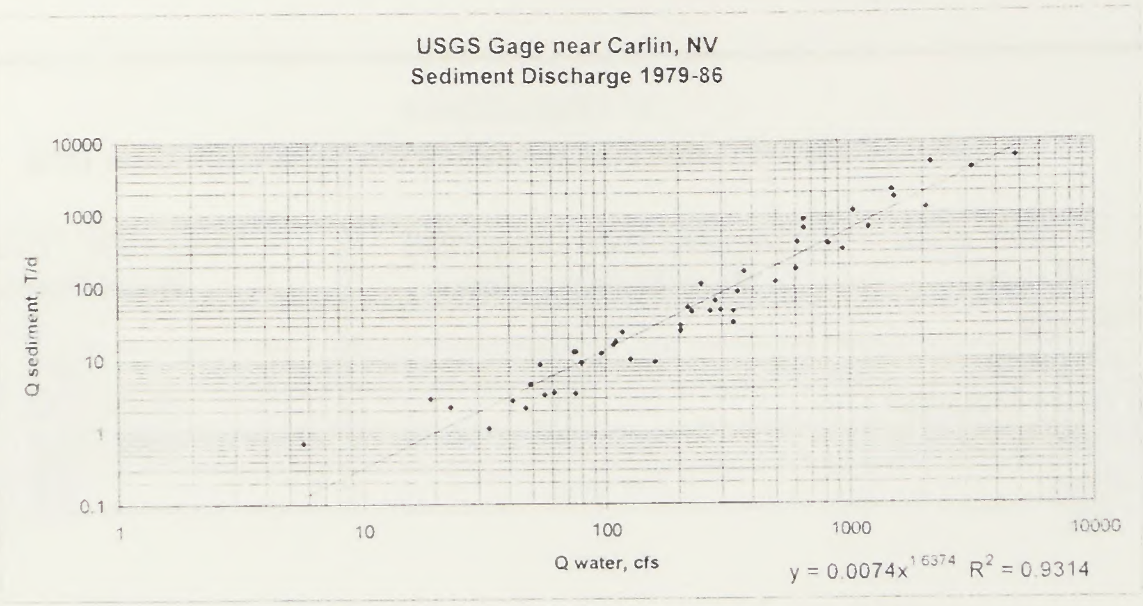
feet/year estimated to evaporate from Rye Patch and Pitt-Taylor reservoirs, it can be seen that on average a substantial amount of river flow was lost from the surface water system between Comus and the USGS gage near Rye Patch. This general concept is supported by more extensive gaging data depicted in Table 3.2-13.

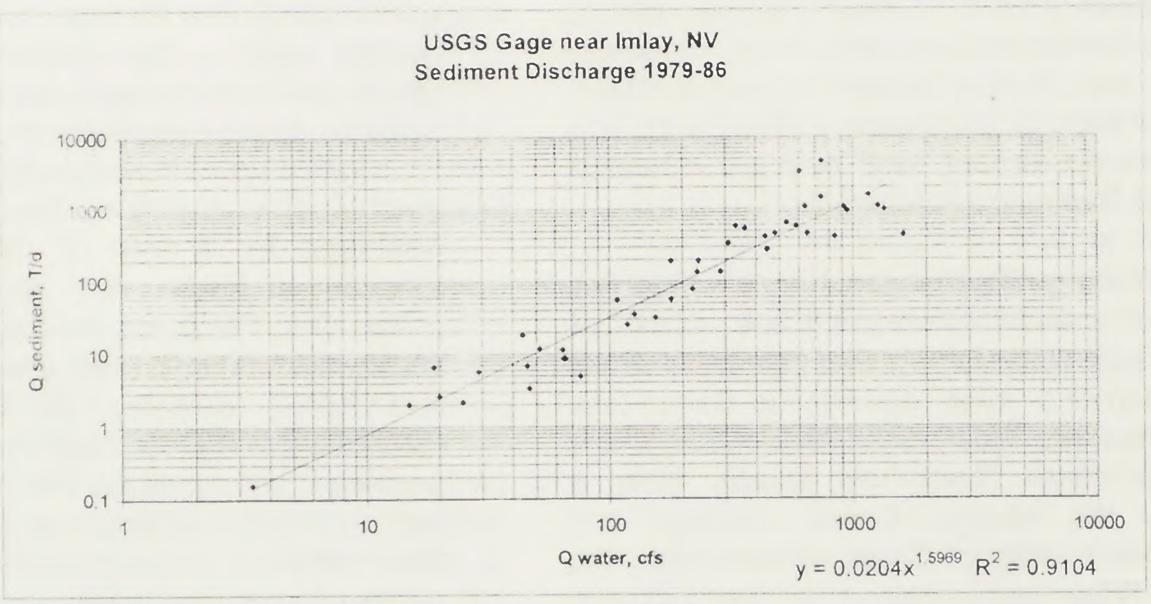
**Existing Mining Discharges.** Since 1992, two mines have operated dewatering operations that affect surface water along the Humboldt River prior to Barrick's mine dewatering discharges. These mines are Newmont's Gold Quarry and Lone Tree mines. The Gold Quarry Mine is located in the Maggie Creek drainage and discharges into Maggie Creek, which enters the Humboldt River just upstream of the Palisade gage (see Figure 1-6); the Gold Quarry Mine was issued a surface water discharge permit in April 1994. The Lone Tree Mine is located downstream of Battle Mountain just upstream of the Comus gage (see Figure 1-6); the Lone Tree Mine was issued a surface water discharge permit in May 1992. Further information on these discharges is presented in the Cumulative Impact Analysis report (BLM 2000b).

**Sediment Discharges.** Humboldt River sediment discharge data from the USGS were examined for the gage locations in the study area that have reasonable periods of record. These gages include the Humboldt River near Carlin, near Imlay, and near Rye Patch (Figure 1-6). Essentially no sediment discharge data exist in the Palisade to Comus area. Sediment discharge data for the period of record common to the gages was plotted, and a line of best fit was determined to relate sediment discharge to flow rate in the river (Figure 3.2-18).

There is considerable variation in the data, even at a single station for a given river flow. However, general relationships can be seen at a single station and between stations. Between Carlin and Imlay, a general increase in sediment discharge for a given water flow can be identified from the graphs. For example, the general sediment discharge for a flow of 100 cfs is about 14 tons/day at Carlin, and about 32 tons/day at Imlay. For 1,000 cfs in the river, the general sediment discharge rates are about 605 tons/day and 1,260 tons/day at Carlin and Imlay, respectively. This is likely due to the increased sediment supply from the additional drainage area and channel length at Imlay versus Carlin. Substantially less sediment discharge occurs for a given flow at the Rye Patch gage in comparison to either Carlin or Imlay. This is due to the sediment trapping effects of Rye Patch Reservoir, which is between the Imlay and Rye Patch gages. The estimated sediment discharges at the Rye Patch gage are about 9 tons/day for a flow of 100 cfs, and about 80 tons/day for a flow of 1,000 cfs.

With regard to data variations, it can be seen that for flows of about 55 cfs at Carlin, the sediment discharges range from about 3.5 to 8.5 tons/day. For flows on the order of 1,000 cfs, sediment discharges range from 325 to 1,120 tons/day. Similar variation exists in the Imlay and Rye Patch data. It should be noted that sediment discharge data portray a synthesis of all the random and instantaneous sediment-related events in the watershed upstream of the monitoring point. Thus, one point in the Carlin data reflects cropland uses, grazing activity and other land uses, the amount and timing of rainfall and snowmelt, re-entrainment of sediment that may have been stored along the channel for





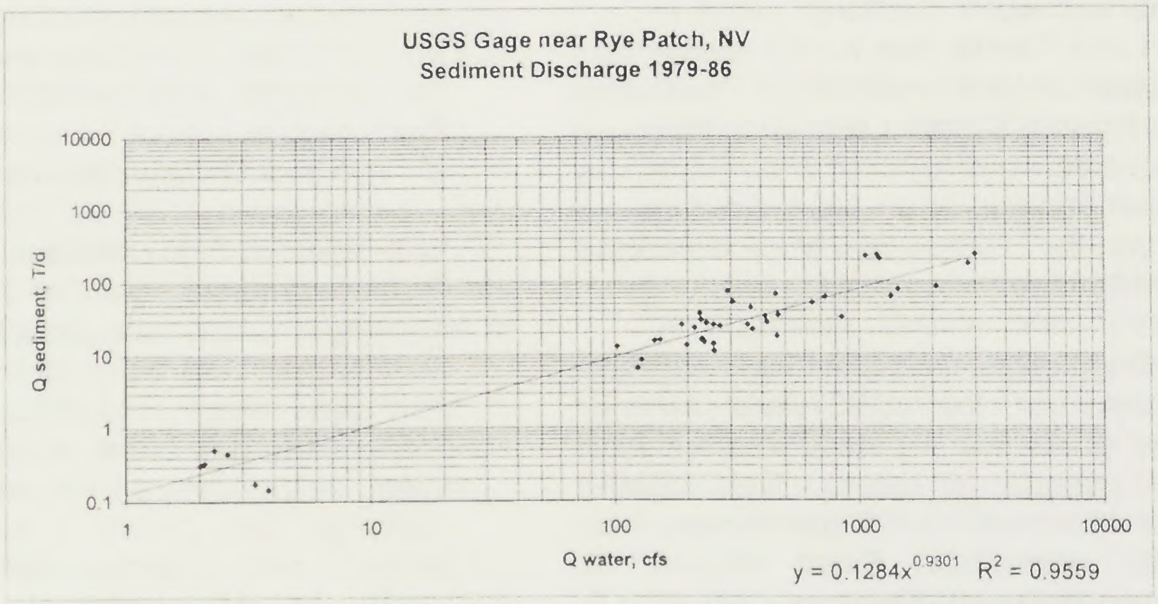


Figure 3.2-18

Humboldt River Sediment Discharges

years, and other incidental disturbances along the river for the entire upstream watershed. Accounting for this multitude of factors historically is unrealistic. The same limitation exists at Imlay and Rye Patch. Therefore, although general statements can be made for data averaged over a period of time, the data do not allow specific causes and effects to be separated at specific times or flow events.

**Regional River Channel Geometry.** The configuration and habitat associations of the Humboldt River have been intensively examined over much of the study region by the Nevada Division of Wildlife (Rawlings and Neel 1989; Bradley and Neel 1990; Bradley 1992; Neel 1994). In particular, these studies included quantification of river length and sinuosity from the Dunphy area to near Rye Patch Reservoir. Sinuosity is the ratio of river length to valley length, and it is commonly used as a measure of river meandering. Higher sinuousity values indicate a higher degree of meandering. Changes in the river over time are shown in Table 3.2-15 for general non-continuous locations in the cumulative study area. The data used to develop Table 3.2-16 are nearly continuous over the length of the river indicated. Small gaps do exist in the data; however, they are reasonably representative of channel conditions along the section from Dunphy to Imlay. The measurements were made from USGS topographic quadrangles, historical aerial photographs, and additional aerial photos taken in 1985 when the investigation was initiated. The date of the historical information used in the analysis is shown in the second column. The 1985 data were used for comparison.

Table 3.2-15 indicates that a net loss of approximately 13.4 miles of river length has occurred between the Dunphy area and the Imlay area over the 2 to 3 decades represented by the data. Substantial loss of river length and sinuosity has occurred in the Dunphy and Argenta area and downstream of Winnemucca. In other locations, such as near Comus and at or slightly upstream of Winnemucca, the river has apparently both increased and decreased its length. Little or no change is shown over much of the river, particularly where the historical data represent conditions only 2 or 3 years prior to 1985. Differences of less than 0.1 mile in river length may be caused by small measurement errors on the maps and photos. From the date of the baseline data, it can be seen that channel changes have occurred to different degrees at different locations. Whether the changes occurred gradually over time or resulted from a few isolated events is not known. A mixture of both long-term and short-term factors probably contributed to the river conditions. However, it is clear that the river geometry has been in flux historically, prior to mining discharges. Some river locations have undergone substantial adjustment, while others are relatively unchanged.

A number of factors must be considered when reviewing Humboldt River channel characteristics. First of all, the concept of stability may have different meanings when applied to a dynamic natural river system. The distinction is between the balance of flow and sediment transport processes within a system in motion versus the immobility of a river's position in relationship to civil boundaries or structures.

Variables such as channel gradient, length, width, depth and sinuosity refer to conditions that may be balanced (dynamic equilibrium) or not as a stream channel migrates or otherwise adjusts itself within an alluvial valley system. From a geomorphic viewpoint, a river can be thought of as being in balance if these relationships are maintained, even though the river may migrate widely across its floodplain. In short, changes in channel position do not necessarily imply instability within the river system. In contrast, efforts to stabilize or maintain the channel position at a given location often promote imbalances elsewhere, both upstream and downstream.

Within the past several decades, several major activities have taken place along the Humboldt River that have affected its position and geometry. These include several miles of federal channel straightening in the 1950s near Argenta and east of Comus. In addition, construction began on what is now the Interstate 80 system in the early 1960s. In combination with railroad structures and a narrow valley, the highway bridges at Dunphy have maintained the channel location there. The river position fluctuates upstream and downstream. In recent decades, several irrigation structures have been built

## Table 3.2-15
## Historical Changes in Humboldt River Configuration

| General Study Location | Historical River Length, miles (date) | 1985 River Length, miles | Total Change, miles | Total Percent Change | Historical Channel Sinuosity | 1985 Channel Sinuosity | Change |
|---|---|---|---|---|---|---|---|
| Dunphy | 19.7 (1965) | 15.1 | -4.6 | -23.4 | 1.62 | 1.25 | -0.370 |
| Argenta/Rock Creek | 15.5 (1957) | 13.7 | -1.8 | -11.6 | 1.26 | 1.11 | -0.150 |
| Battle Mountain Area | 3.8 (1957) | 3.7 | -0.1 | -2.6 | 1.69 | 1.64 | -0.050 |
| Valmy | 20.1 (1954) | 16.3 | -3.8 | -18.9 | 2.53 | 2.05 | -0.480 |
| Valmy | 6.0 (1976) | 5.2 | -0.8 | -13.3 | 2.06 | 1.79 | -0.270 |
| Valmy | 3.4 (1965) | 3.1 | -0.3 | -8.8 | 1.10 | 1.06 | -0.040 |
| Valmy | 3.5 (1965-66) | 3.5 | 0.0 | 0.0 | 1.17 | 1.17 | 0.000 |
| Valmy | 18.6 (1965) | 17.8 | -0.8 | -4.3 | 1.58 | 1.57 | -0.010 |
| Comus | 5.4 (1965) | 5.3 | -0.1 | -1.9 | 1.28 | 1.26 | -0.020 |
| Comus | 5.0 (1945, 1965) | 5.3 | 0.3 | 6.0 | 1.85 | 1.96 | 0.110 |
| Golconda | 1.5 (1965, 1983) | 1.6 | 0.1 | 6.7 | 1.50 | 1.60 | 0.100 |
| Golconda | 20.5 (1965) | 20.1 | -0.4 | -2.0 | 1.71 | 1.68 | -0.030 |
| Winnemucca | 7.6 (1983) | 8.4 | 0.8 | 10.5 | 1.81 | 1.74 | -0.070 |
| Winnemucca | 3.6 (1983) | 3.5 | -0.1 | -2.8 | 1.16 | 1.13 | -0.030 |
| Winnemucca | 4.7 (1983) | 4.7 | 0.0 | 0.0 | 2.35 | 2.35 | 0.000 |
| Winnemucca | 3.5 (1982-83) | 3.5 | 0.0 | 0.0 | 1.84 | 1.84 | 0.000 |
| Winnemucca | 5.3 (1982-83) | 5.3 | 0.0 | 0.0 | 2.41 | 2.41 | 0.000 |
| Winnemucca | 5.8 (1976) | 5.7 | -0.1 | -1.7 | 2.23 | 2.19 | -0.040 |
| Below Winnemucca | 11.7 (1976) | 10.3 | -1.4 | -12.0 | 2.21 | 1.94 | -0.270 |
| Imlay | 17.4 (1976, 1982) | 17.1 | -0.3 | -1.7 | 1.66 | 1.63 | -0.030 |
| **TOTAL** | **182.6** | **169.2** | **-13.4** | **-7.3** | | | |

Source: Bradley and Neel 1990; Bradley 1992; Neel 1994.

## Table 3.2-16
## Humboldt River Channel Sinuosity Over Time, Dunphy to Mosel

| Reach | 1979 | 1982 | 1983 | 1994 |
|---|---|---|---|---|
| Upstream | 1.82 | 1.59 | 1.53 | 1.48 |
| Downstream | 1.40 | 1.21 | 1.20 | 1.35 |

across the river as well. Over a longer time, railroad and municipal embankments have been built and maintained, and streamside vegetation has been altered as a result of various land use conversions (Rawlings and Neel 1989).

In 1984, extremely high flows occurred naturally in the Humboldt River. The highest recorded instantaneous peak flow at the Comus gage occurred on April 24 of that year, and was 9,900 cfs. The highest recorded daily mean flow occurred the next day, and was 9,640 cfs (USGS 1999). On the basis of data gathered since 1946, these flows were roughly 10 times the peak flow for an average year at the Comus gage. The extreme flows cut across meanders, eroded banks, scoured the existing bars and terraces, and created new sediment deposits either as bars or thin veneers over the lower terraces.

It is probable that over several decades, alterations and infrastructure development all along the river have essentially anchored several locations into place and caused other reaches to continually adjust. Preliminary USGS information for the gage at Comus indicates that between

1988 and 1997, the river channel has widened and filled such that the general bottom elevation was between 0.5 feet and 1.5 feet higher in 1997 than in 1988 (USGS 1999). In addition, aerial photographs indicate that several meanders have been cut off immediately upstream of the gage since the 1960s. Extensive lateral migration of the river channel also has occurred historically in the Dunphy area near Barrick's outfall.

**Local River Channel Characteristics.** Aerial photography and photo-based topographic maps were inspected for the river reach near Barrick's outfall for the years 1979, 1982, 1983, and 1994. The Humboldt River is a sinuous point-bar channel over the area examined in detail, which extends approximately 8 miles upstream and downstream of Barrick's outfall. It has maintained this overall configuration since 1979, through both the drought years and the highest flows on record. Tectonic influences on the river in the last 20 years or so are unknown. However, the river grades to a sinuous braided channel for a short reach just upstream of the Dunphy Road bridge, approximately 2.5 to 3 miles upstream of Barrick's outfall.

USGS topographic quadrangles for the area were developed from aerial photography taken in 1982. Based on these maps, main channel sinuosities (river length divided by straight air length) range widely between Whirlwind Valley (just north of Beowawe, Figure 1-6) and the Argenta area. Main channel sinuosity is high in Whirlwind Valley itself, typically approximately 2.0. As the river leaves the valley, the value drops to 1.3 for approximately 2 miles above the Interstate 80 bridge. From Interstate 80 to just below Barrick's outfall (approximately 3.5 miles) the value increases to 1.6. Below the outfall, sinuosity decreases again to approximately 1.2 down to the TS Ranch bridge, except for a short stretch approximately 1 mile above the bridge with sinuosity of 1.6. As shown in 1994 aerial photographs, the main channel in the latter area has naturally straightened to match the rest of the locale since the topographic mapping was completed. Below the bridge, sinousity increases slightly to 1.3 for a couple of miles and then decreases again to 1.1 or even less at Argenta. Long, straight sections of the river occur in the Argenta area, probably caused by a combination of natural and man-made factors.

Based on the 1982 topography, channel bed slope in Whirlwind Valley is approximately 1.4 feet per mile. Above the Interstate 80 bridge, the main channel slope averages approximately 3.7 feet per mile. From the bridge to approximately 0.5 mile above Barrick's outfall, the slope averages approximately 6.4 feet per mile. From there, the main channel slope flattens gradually, reaching approximately 4 feet per mile in the Argenta vicinity. These values are approximate; somewhat steeper and flatter sections are interspersed throughout the river length. The slope of the reach that straightened out approximately 1 mile above the TS Ranch bridge was considerably flatter in 1982 than the reaches on either side of it. Main channel slope and meander adjustments such as this occur regularly in the area. The slope of the low-flow channel is probably somewhat flatter in general than the values presented since general map contours were used to determine these slopes, and typically the low-flow channel meanders somewhat within the wider channel shown on maps.

Channel banks are typically steep to nearly vertical. Bank erosion has been an active agent historically over much of the area studied and presently continues. Bank materials in the outfall locale demonstrate some degree of cohesion, and samples contain 80 to 90 percent very fine sand, silt, and clay (Simons & Associates, Inc. 1997). Bed materials in the locale consist primarily of gravel and sand, with minor amounts of cohesive materials (Simons & Associates, Inc. 1995d). Mean grain size in the bed is approximately 20 millimeters (gravel) in most sampled locations. Point bars occur on the inside of most bends, and have relatively gentle slopes with a mixture of material sizes.

Floodplain width ranges from approximately 2,000 to 4,000 feet, depending on the location. Within this width, numerous and extensive abandoned meanders and subsidiary channels exist. Anabranches occur in the form of narrow, highly sinuous side channels that are common in Whirlwind Valley and at other locations downstream. Historically, the main channel has migrated frequently and widely throughout its floodplain.

Levees, spoil banks, and other river controls, such as bridges, dams, and railroad grades, occur extensively throughout the portion of the river from lower Whirlwind Valley to Argenta. These features provide varying degrees of control on river position and consequently influence river adjustments over much of the flow range. At or near Dunphy, three bridges cross the river. An additional bridge crosses at Mosel, and a network of levees and spoilbanks occur in combination with a concrete overflow spillway in the Argenta area. These features persisted through the highest recent flow year (1984). The Argenta gage washed out and was not replaced following 1983; however, based on statistical relationships with other gages (RTi 1998), the peak monthly discharge at Argenta in late May of 1984 was approximately 6,300 cfs.

A relatively stable reach occurs downstream of the former USGS gage site above the TS Ranch bridge at Mosel. Another occurs upstream of the Interstate 80 bridge above Dunphy and on into Whirlwind Valley. Between these locations, the river has historically modified its course a number of times in different locations within the last 20 years or so. Examples of this can be seen in Figure 3.2-19. Barrick's outfall is located within this more active stretch of the river. Changes in river position are shown over a 4-year period (1979 to 1983) in Figure 3.2-19. Changes over a 15-year period (1979 to 1994) are shown in Figure 3.2-19. Channel shifts for an intermediate 11-year period (1983 to 1994) can be seen by comparing the relevant traces between the two diagrams for a particular location. While the river has not dramatically migrated across the width of its floodplain during these years, it can still be seen that substantial shifts in channel position have occurred naturally between Mosel and the Interstate 80 bridge near Dunphy. Continuing channel shifts near Dunphy in 1995 and1996 are further illustrated by on-site photographs in the JBR Humboldt River baseline monitoring report (JBR 1997).

Historical changes in sinuosity were examined for the reaches immediately above and below the Barrick outfall. Although variations in channel sinuosity occur within short distances over the entire length of the river from Whirlwind Valley to Battle Mountain, longer reaches can be generalized. For comparative purposes, two reaches were selected visually, based on apparent similarity in general river configuration as shown on the 1982 photo-based topographic quadrangles. The upstream reach extended from a straight section approximately 2,000 feet below the Interstate 80 bridge, to a point approximately 800 feet below the outfall. The downstream section extended from the latter location to a point just above the pair of high-amplitude meanders halfway to Mosel. (These positions can be seen in Figure 3.2-19). The overall sinuosity values through time for the two selected reaches are shown in Table 3.2-16. As can be seen from the table, the upstream reach has consistently straightened since 1979. In contrast, the downstream reach has fluctuated over time. Nearer the outfall, the downstream reach has actually become more sinuous in recent years than the table indicates.

## Regional Features and Conveyance Structures

In addition to water management systems associated with mining and municipal uses, numerous flow structures and conveyances occur within the study area. These are primarily used for agricultural purposes and form a complex system of diversions and returns on the Humboldt River and its tributaries. Notable diversion features from east to west along the main Humboldt River channel are listed for the study reach in Table 3.2-17. Additional ditches and controls interconnect river tributaries throughout the study area. White House Ditch, Blue House Ditch, and Rock Creek Ditch are examples of these structures in Boulder Valley. Occasionally, man-made links between the river and its tributaries have been made at locations other than the natural confluences. Examples of this occur in the Battle Mountain locale along the Reese River and Rock Creek.

Historically, an area of wetlands, abandoned channels, and associated wildlife habitats existed in the Argenta area in Lander County about half way between Battle Mountain and Dunphy near the former Argenta stream gage (see Figure 1-6). This area was informally known in the region as the Big Slough. Its size ranged between 1,500 acres and 5,000 acres, depending on the source of the information (Elko Daily Free Press 1997). It formed part of the Community Pasture

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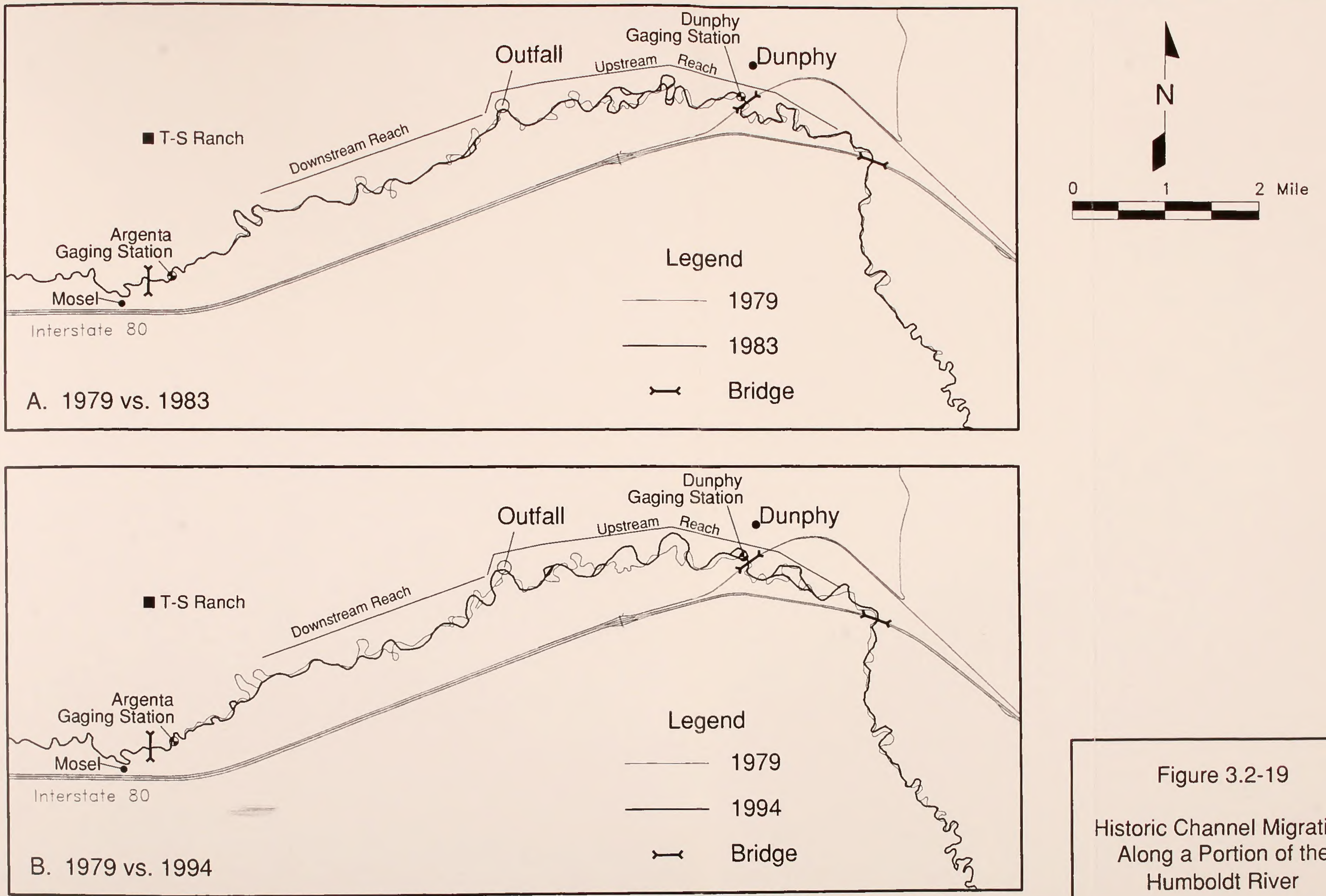

Figure 3.2-19

Historic Channel Migration Along a Portion of the Humboldt River

### Table 3.2-17
### Major Conveyance Structures Within the Humboldt River Study Area

| Structure | Approximate Location |
|---|---|
| Diversion flumes | 1 mile southwest of Carlin |
| Diversion dam and ditch system | Harney, 8 miles east of Beowawe |
| Anderson-Highline Canal takeout | 3 miles southeast of Beowawe |
| Corbett Canal takeout | 2 miles southeast of Beowawe |
| Merchant Canal system takeout | Beowawe |
| Westside Ditch takeout | Beowawe |
| Rose Canal takeout | 3.5 miles southeast of Dunphy |
| White House Dam | Dunphy |
| Bluehouse Ditch | 3 miles east of Dunphy |
| Ditch | 3 miles east of Battle Mountain |
| 25 Ranch ditch system | 7 miles northwest of Battle Mountain |
| Ditch | Ellison Ranch |
| The Dike | 2 miles south of White House Ranch |
| Ditch | White House Ranch |
| Dam | Red House |
| Dam | 2 miles west of Red House |
| Dam | 1.5 miles southeast of Comus |
| Stahl Dam and French Canal diversion | 2 miles east of Golconda |
| CS Dam | 3 miles southeast of Button Point |
| Various dikes, headgates, and ditches | Button Point vicinity |
| Reinhart Dam | 1.5 miles north of Winnemucca |
| Diversion dams and ditch system | 2 miles northeast of Rose Creek |
| Pitt-Taylor Diversion Canal takeout | 1.5 miles north of Mill City |
| Pitt-Taylor Dam and reservoirs | 2.5 miles west of Humboldt |
| Rye Patch Dam and reservoir | 1.5 miles northwest of Rye Patch |
| Young Dam, levees and diversion takeout | 2 miles north of Colado |
| Pitt Dam | 4.5 miles northeast of Lovelock |
| Irish-American Dam | 3.5 miles northeast of Lovelock |
| Rogers Dam | 1.5 miles northeast of Lovelock |
| Numerous gates, canals, ditches, and flumes | Lovelock area and downstream |

bought by the U.S. Bureau of Reclamation in the 1930s in an effort to acquire water rights for Rye Patch Reservoir. The reservoir, pasture, and associated irrigation and water management infrastructure collectively form the Humboldt Project, which was approved by Congress in the 1930s. Water rights for the Community Pasture lands were transferred downstream to support the project, which is operated and paid for by the Pershing County Water Conservation District. Until the late 1950s, the marsh area supported extensive zones of willow and other riparian and wetland communities that, in turn, provided habitat for large numbers of waterfowl, as well as shorebirds, upland game birds, deer, and antelope (McColm 1994).

During the late 1950s, the area was drained by a Federal river channelization project, which straightened the course of the river for several miles through the Argenta vicinity and elsewhere along the river. The purpose of the channelization project was to conserve water in the river by reducing seepage and evapotranspiration, and ultimately to ensure that the water rights purchased by the U.S. Bureau of Reclamation actually resulted in additional water being supplied to the reservoir. The channelization was devised and undertaken by the U.S. Bureau of Reclamation, as a result of a directive from the Nevada Department of Conservation and Natural Resources to demonstrate that the amount of water acquired was actually available at Rye Patch and downstream.

In recent years, this area has been referred to as the former Argenta Marsh. Having complied with the Humboldt Project reimbursement schedule for decades, the Pershing County Water Conservation District has recently applied to the Federal government to receive title to the Humboldt Project properties. This process has generated public comment and involvement concerning the use and management of project lands. The concept of restoring water to the Argenta Marsh and improving habitats there has been supported by the Nevada Division of Wildlife and other public and private organizations, although the actual mechanisms for doing so require further definition and examination. Conceivably, mine discharge water could be diverted into the area through an old system of irrigation ditches. The feasibility of marsh restoration, water rights issues, and the long-term maintenance of marsh habitats after mine discharges cease are ongoing topics of discussion between the Pershing County Water Conservation District and other entities in the region.

The Humboldt River terminates at the Humboldt Sink approximately 15 miles southwest of Lovelock. The sink consists of two shallow lakes, Humboldt Lake and Toulon Lake, and a large area of alkali flats (Figure 3.2-20). The extent of the lakes varies widely from year to year, depending on the amount of water flowing into them from the river and agricultural drains. The total land area at the sink is on the order of 40 square miles.

The river is channelized for several miles upstream of the sink. Other major drains near the sink include the Toulon, Army, Lovelock Irrigation and the Graveyard drains, which primarily route agricultural return flows. Ultimately the drainages combine so that the Toulon Drain, Army Drain, and the Humboldt River form the major surface water conveyances into the Humboldt Sink.

When water is available, the Humboldt Drain at the southwestern end of Humboldt Lake allows conveyance of water out of the Humboldt Sink to the nearby Carson Sink through an area of alkali flats and the Humboldt Slough. Recent USGS data indicate that flows between approximately 550 to 950 cfs passed through the Humboldt Drain toward the Carson Sink in the late summer of 1998 (USGS 1999b). The USGS gage near Carlin exhibited nearly average flows for that period as did the gages at Imlay and Rye Patch. It is not known if the flows through the Humboldt Drain in 1998 are representative of average conditions or how much of that flow actually reached the Carson Sink.

The USGS operated a streamflow gaging station on the Humboldt River downstream of Lovelock from 1950 to 1959, and has conducted new gaging and sampling at the location in 1998 and 1999 (USGS 1999b; Thodal 2000). Flows in the latter period include recent high flow years as well as possible effects from mine dewatering. They are within the range of flows exhibited at the gage from 1950 through 1959. The 1950s were comprised of both high flow years and low flow years on the river, but are somewhat lower in overall average compared with the periods of record at other gages used in this assessment. However, the earlier period (1950 through 1959) reflects conditions prior to flow contributions from mine dewatering and, as such, these data have been used to characterize baseline (existing) conditions for the purposes of impact assessment.

Based on these limited flow measurement data, approximately 42,000 acre-feet of water per year flowed into the sink via the river below Lovelock. A very general assumption for the average annual diversion rate for the Lovelock Valley can be estimated by subtracting the river flows past Lovelock (available for 1950 through 1959) from the Rye Patch gage flows for the same period. This indicates that on the order of 105,000 acre-feet/year were diverted for use in the Lovelock Valley. Both high and low flows are represented in this period, although the Rye Patch average for the period is only about 75 percent of the 1946-90 average. Assuming a 30 percent return from the

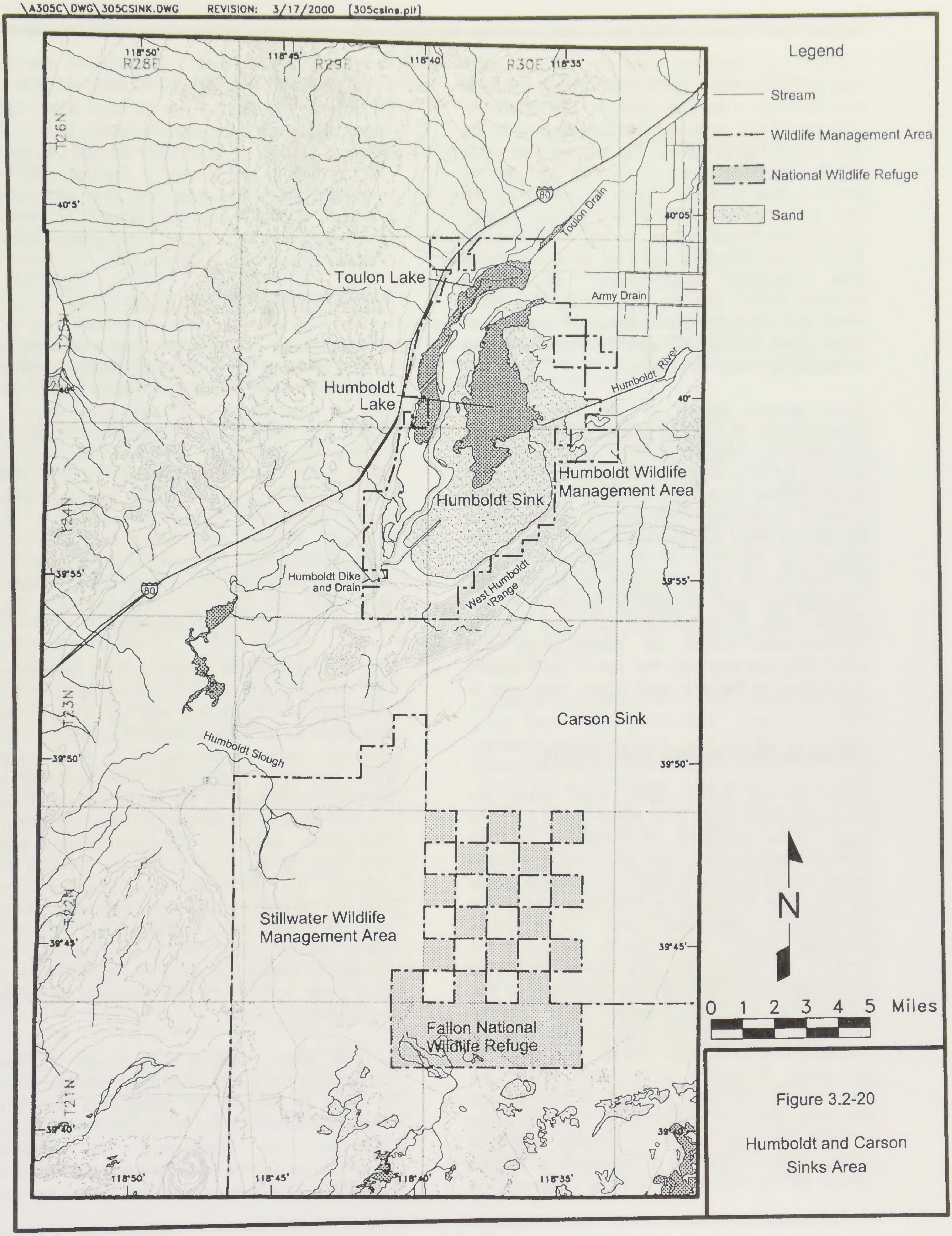

Figure 3.2-20

Humboldt and Carson Sinks Area

105,000 acre-feet/year diversion, 31,500 acre-feet/year also flowed to the sink through seepage and drains as a general estimate. Coincidentally, with the 42,000 acre-feet per year flowing in the river, these figures sum to the approximate value (74,000 acre-feet/year) of surface and ground water outflow from the Humboldt basin into the sink as indicated by Eakin and Lamke (1966). Normalizing these values to the 1946 through 1990 period of record used for other premining flow analyses, approximately 56,500 acre-feet/year flowed into the sink through the lower river, and 42,500 acre-feet/year of agricultural return flows entered the sink through drains and seepage, as broad estimates.

Mean annual rainfall in the sink area is approximately 5.4 inches (National Oceanic and Atmospheric Administration - Cooperative Institute for Environmental Sciences 1999). With approximately 40 square miles of area, on the order of 11,500 acre-feet/year are contributed to the sink by direct precipitation. Combined with the inflows, on the order of 110,000 acre-feet/year are lost at the Humboldt Sink by evaporation, transpiration, and occasional overflow to the Carson Sink. Note that this is a very general approximation based on limited data and simplifying assumptions; the actual contributions and losses at the sink vary widely from year to year.

### Humboldt River Surface Water Rights

Many surface water rights exist within the Humboldt River study area, some dating from the early 1860s. Hundreds of rights are held for diversion of river water, and additional rights exist along the tributaries. A listing of all these would be too large to include in this document, but a summary is presented Table 3.2-18 below (Hennen 1964). Table 3.2-18 indicates the amount of water on the lower Humboldt (generally below Palisade) that was decreed and permitted by the State Engineer as of calendar year 1963, and can serve as an approximation for characterizing potentially affected resources. In the entire Humboldt River basin, there are approximately 667,000 acre-feet of decreed and permitted water on approximately 266,000 acres of land (Hennen 1964). A concise listing of surface water rights and a discussion of related issues for the Humboldt River is presented in *Humboldt River Water Distribution* (Hennen 1964), although changes have occurred since its publication. Humboldt River surface water rights above Palisade are administered under the Edwards Decree of 1935. The Bartlett Decree of 1931 applies to and is used in the distribution of river water below Palisade. Additional information is publicly available from the Nevada Department of Conservation and Natural Resources, Division of Water Resources, in Carson City.

### Humboldt River Water Quality

Available water quality information was compiled for all Humboldt River stations located between Carlin and the Humboldt Sink. Water quality data exist for most of the monitoring sites shown in Figure 1-6. Since mining-related discharges to the river began in early 1991, however, only the data collected from approximately 1970 to 1990 was applicable for describing premine water quality conditions. Based on review of the database, it was determined that the most representative data for premine water quality in the Humboldt River was USGS data collected near Carlin (USGS Gage 10321000) and near Rye Patch (USGS Gage 10335000).

Data from other water quality stations were much less complete and were not considered in this evaluation. The Carlin site was also selected for evaluation since it represents conditions in the upstream reach of the Humboldt River study area. The Rye Patch site was selected to represent conditions in the lower portion of the river immediately above the Lovelock agricultural development. Below the Rye Patch gage, a large percentage of the river flows are diverted for irrigation. The Humboldt River and the Army Drain are the primary sources of flow to Humboldt Lake; the Toulon Drain is the primary source of flow to Toulon Lake. Only a few samples are available to define the water quality for each of these three sources for the premine discharge period (prior to 1991).

**Surface Water Quality Standards**. Surface water quality standards have been established by the State of Nevada for designated beneficial uses associated with the Humboldt River. These standards are prescribed in Nevada Administrative Codes 445A.144 and 445A.203 to 445A.208, inclusive. Beneficial uses for the

### Table 3.2-18
### Approximate Five-county Acreage with Humboldt River Water Rights, and Annually Decreed and Permitted Water on the Lower River[1]

| County | Acreage | Acre-feet of Water |
|---|---|---|
| Elko | 4,726 | 8,702 |
| Eureka | 20,235 | 34,427 |
| Lander | 27,633 | 42,085 |
| Humboldt | 23,950 | 46,980 |
| Pershing | 40,884 | 144,833 |
| **TOTAL** | **117,428** | **277,027** |

Source: Hennen 1964.

[1] In this tabulation, the area on the main stem and on Maggie Creek west of the Eureka-Elko county line is also credited to the lower river (below Palisade). The actual acreage and acre-feet of water decreed and permitted on the river is somewhat different, due to changes over the years, duplications in the decree, and the occurrence of permits issued by the State Engineer that are not included in the data given by the decree (Hennen 1964).

Humboldt River are defined in Nevada Administrative Code 445A.202 and include irrigation; livestock watering; contact and non-contact water recreation; industrial, municipal, and domestic supply; propagation of wildlife; and propagation of aquatic life including warm-water fisheries. Beneficial uses and water quality standards for the Humboldt River near Palisade and Woolsey are also listed in Table 3.2-19. Water quality standards for the Palisade control point are applicable to data collected from the Humboldt River USGS Gage near Carlin (Figure 1-6). Likewise, standards for the Woolsey control point apply to data collected from the Humboldt River USGS Gage near Rye Patch (Figure 1-6).

**General Surface Water Quality**. Water quality data summaries from the USGS gages near Carlin and Rye Patch are listed in Table 3.2-20. For January 1970 through April 1991, streamflows in the Humboldt River near Carlin ranged from 5.7 to 8,130 cfs and from 0.3 to 3,010 cfs near Rye Patch. Average flow values decreased from 473 cfs near Carlin to 334 cfs near Rye Patch. The decrease in flow through the river section is likely the result of diversions out of the river and evaporative losses. It is also likely that flow losses due to evapotranspiration, and sources providing additional constituent loads, contributed to an increase in average TDS concentration calculated through the river section. Average concentrations of TDS increased from 294 mg/L near Carlin to 548 mg/L near Rye Patch.

An average water temperature of 12°C and dissolved oxygen concentration of approximately 10 mg/L was calculated for both monitoring locations (Table 3.2-20). In addition to temperature and dissolved oxygen, average pH values were similar near both Carlin (8.4) and Rye Patch (8.5). As illustrated by the average values, measurements of pH were only slightly higher in the Humboldt River near Rye Patch, with two measurements during the period of record exceeding the propagation of wildlife standard (9.0).

Average concentrations of total suspended solids near Rye Patch (43.4 mg/L) were less than average concentrations near Carlin (159 mg/L). Likewise, the average turbidity was less near Rye Patch (13.6 NTU) than near Carlin (36.9 NTU). While 16% of the measurements near Carlin exceeded the turbidity standard of 50 NTU, no exceedances were measured near Rye Patch. Additionally, for the period of record, the total suspended solids standard near Carlin (annual median value less than 80 mg/L) was exceeded in 42 percent of the years with available total suspended solids data (1979 through 1990). No total suspended solids standard exceedances were measured near Rye Patch. These results likely reflect the ability of Rye Patch Reservoir to settle suspended particles from river flows.

The average total phosphorus value for the Humboldt River near Carlin (0.16 mg/L as P) was greater than the standard for the propagation of aquatic life including warm-water fisheries (0.1 mg/L as P seasonally from April through

## Table 3.2-19
## Water Quality Standards for the Humboldt River at Palisade and Woolsey Control Points

| | | | Propagation of Aquatic Life (warm water) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Constituent | Units | Municipal or Domestic Supply | Single Value Limit | 1-hour Avg. | 96-hour Avg. | Propagation of Wildlife | Water Contact Recreation | Irrigation | Watering of Livestock |
| **Physical and Aggregate Properties** | | | | | | | | | |
| Alkalinity | mg/L as $CaCO_3$ | | (a) | | | 30-130 | | | |
| Color | color units | NAE | | | | | | | |
| TDS | mg/L @180°C | 500[1,3]/<br>1000[2,3] | | | | | | | 3000 |
| Temperature | °C | | | | | | 15-34 | | |
| Temperature (ΔT) | °C | | | | | | 2 | | |
| TSS | mg/L @103-5C | | 80[4] | | | | | | |
| Turbidity | NTU | | 50 | | | | | | |
| **Inorganic Nonmetallic Constituents** | | | | | | | | | |
| Ammonia, unionized | mg/L as $NH_3$ | | 0.02 | | | | | | |
| Chloride | mg/L as Cl | 250 | | | | | | | |
| Cyanide | mg/L as CN | 0.2 | | 0.022 | 0.0052 | | | | |
| Dissolved Oxygen | mg/L as $O_2$ | | ≥5.0 | | | | | | |
| Fluoride | mg/L as F | | | | | | | 1.0 | 2.0 |
| Nitrate | mg/L as N | 10 | | | | | | | |
| Nitrite | mg/L as N | 1.0 | | | | | | | |
| pH | standard units | | | | | 6.5-9.0 | 6.5-9.0 | | |
| ΔpH | standard units | | ±0.5 | | | | | | |
| SAR | ratio | 8[3] | | | | | | 8[3] | |
| Sulfate | mg/L as $SO_4$ | 250 | | | | | | | |
| Total Phosphorus | mg/L as P | | | | 0.1[5] | | | | |
| **Metals and Semi-metals[6]** | | | | | | | | | |
| Antimony | µg/L as Sb | 146 | | | | | | | |
| Arsenic (total) | µg/L as As | 50 | | | | | | 100 | 200 |
| Arsenic (III) | µg/L as As | | | 342[7] | 180[7] | | | | |
| Barium | µg/L as Ba | 2000 | | | | | | | |
| Beryllium | µg/L as Be | 0 | | | | | | 100 | |
| Boron | µg/L as B | | | | | | | 750 | 5,000 |
| Cadmium | µg/L as Cd | 5 | | 5.3[7,8] | 1.3[7,8] | | | 10 | 50 |
| Chromium (total) | µg/L as Cr | 100 | | | | | | 100 | 1,000 |
| Chromium (III) | µg/L as Cr | | | 2,057[7,8] | 245[7,8] | | | | |
| Chromium (VI) | µg/L as Cr | | | 15[7] | 10[7] | | | | |
| Copper | µg/L as Cu | | | 22.1[7,8] | 14.2[7,8] | | | 200 | 500 |
| Iron | µg/L as Fe | | 1,000 | | | | | 5,000 | |
| Lead | µg/L as Pb | 50 | | 68.4[7,8] | 1.3[7,8] | | | 5,000 | 100 |
| Manganese | µg/L as Mg | | | | | | | 200 | |
| Mercury | µg/L as Hg | 2 | | 2[7] | 0.012 | | | | 10 |
| Molybdenum | µg/L as Mo | | 19 | | | | | | |
| Nickel | µg/L as Ni | 13.4 | | 1,699[7,8] | 189[7,8] | | | 200 | |
| Selenium | µg/L as Se | 50 | | 20 | 5.0 | | | 20 | 50 |
| Silver | µg/L as Ag | | 6.9[7,8] | | | | | | |
| Thallium | µg/L as Tl | 13 | | | | | | | |
| Zinc | µg/L as Zn | | | 140[7,8] | 127[7,8] | | | 2,000 | 25,000 |

Source: Nevada Administrative Code 445A.144, 445A.204, and 445A.208.

[1] Applicable to Palisade control point.

[2] Applicable to Woolsey control point.

[3] Annual average.

[4] Annual median.

[5] Seasonal water quality standard from April to November.

[6] The standards for metals are expressed as total recoverable, unless otherwise noted.

[7] Standard applies to the dissolved fraction.

[8] Hardness-derived standard (Nevada Administrative Code 445A.144). Values calculated assuming a hardness of 150 mg/L as $CaCO_3$.

(a) = Less than 25 percent change from natural conditions; TDS = total dissolved solids; TSS = total suspended solids; SAR=sodium adsorption ratio; NAE=No Adverse Effects; single concentration limits and 24-hour average concentration limits must not be exceeded; 1-hour average and 96-hour average concentration limits may be exceeded only once every 3 years.

## Table 3.2-20
## Humboldt River Water Quality
## (January 1970 through April 1991)

| | | Carlin Gage (USGS 10321000) | | | | Rye Patch Gage (USGS 10335000) | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Constituent** | **Units** | n | Min. | Max. | Avg.[1] | n | Min. | Max. | Avg.[1] |
| Stream Discharge | cfs | 97 | 5.7 | 8130 | 473 | 121 | 0.3 | 3010 | 334 |
| **Physical and Aggregate Properties** | | | | | | | | | |
| Alkalinity | mg/L as CaCO3 | 37 | 143 | 280 | 210 | 121 | 185 | 295 | 248 |
| Hardness | mg/L as CaCO3 | 79 | 80 | 219 | 162 | 134 | 116 | 217 | 171 |
| Temperature | °C | 95 | 0.0 | 26 | 12 | 178 | 2.5 | 25 | 12 |
| TDS | mg/L @ 180°C | 77 | 178 | 414 | 294 | 95 | 407 | 774 | 548 |
| TSS | mg/L @ 103-5 °C | 75 | 10 | 2440 | 159 | 106 | 14 | 136 | 43.4 |
| Turbidity | NTU | 79 | 0.8 | 640 | 36.9 | 67 | 0.7 | 48 | 13.6 |
| **Inorganic Nonmetallic Constituents** | | | | | | | | | |
| pH | standard units | 75 | 7.6 | 8.9 | 8.4 | 149 | 7.6 | 9.6 | 8.5 |
| Dissolved Oxygen | mg/L as O2 | 71 | 6.7 | 15.2 | 10.4 | 67 | 7.4 | 16.1 | 9.9 |
| Nitrite | mg/L as N | 28 | <0.01 | 0.08 | 0.02 | 64 | <0.01 | 0.06 | 0.01 |
| Nitrate | mg/L as N | 23 | <0.01 | 0.30 | 0.06 | 62 | <0.01 | 0.1 | 0.03 |
| Phosphorous, Total | mg/L as P | 79 | <0.01 | 1.2 | 0.16 | 121 | 0.01 | 0.31 | 0.09 |
| Cyanide | mg/L as CN | 0 | - - - | - - - | - - - | 0 | - - - | - - - | - - - |
| Chloride | mg/L as Cl | 78 | 6.9 | 40 | 17.0 | 137 | 43 | 230 | 101.1 |
| Sulfate | mg/L as SO4 | 77 | 11 | 60 | 33.5 | 130 | 40 | 100 | 74.5 |
| Fluoride | mg/L as F | 79 | <0.1 | 1.3 | 0.5 | 105 | 0.4 | 1.2 | 0.8 |
| **Metals and Semi-metals (dissolved)** | | | | | | | | | |
| Antimony | µg/L as Sb | 0 | - - - | - - - | - - - | 0 | - - - | - - - | - - - |
| Arsenic | µg/L as As | 49 | 3 | 14 | 7.2 | 44 | 16 | 60 | 31 |
| Barium | µg/L as Ba | 48 | 49 | 140 | 89 | 31 | 25 | 82 | 45 |
| Beryllium | µg/L as Be | 34 | <0.5 | 0.7 | <0.5 | 12 | <0.5 | 0.5 | <0.5 |
| Boron | µg/L as B | 2 | 120 | 180 | 150 | 7 | 260 | 580 | 471 |
| Cadmium | µg/L as Cd | 48 | <1 | 2 | <1 | 39 | <1 | 2 | <1 |
| Chromium | µg/L as Cr | 48 | <1 | 7 | 1.1 | 44 | <1 | 20 | 2.0 |
| Copper | µg/L as Cu | 49 | <1 | 13 | 3.2 | 44 | <1 | 9 | 3.6 |
| Iron | µg/L as Fe | 49 | <3 | 130 | 22 | 44 | <3 | 70 | 15 |
| Lead | µg/L as Pb | 47 | <1 | 10 | 1.9 | 40 | <1 | 11 | 1.5 |
| Manganese | µg/L as Mn | 49 | <1 | 56 | 12 | 43 | <1 | 40 | 7.8 |
| Mercury | µg/L as Hg | 49 | <0.1 | 0.5 | <0.1 | 44 | <0.1 | 1.8 | 0.2 |
| Molybdenum | µg/L as Mo | 34 | <10 | 10 | <10 | 12 | <10 | 20 | <10 |
| Nickel | µg/L as Ni | 47 | <1 | 6 | 1.7 | 25 | <1 | 9 | 2.1 |
| Selenium | µg/L as Se | 49 | <1 | 1 | <1 | 44 | <1 | 1 | <1 |
| Silver | µg/L as Ag | 49 | <1 | 1 | <1 | 32 | <1 | <1 | <1 |
| Zinc | µg/L as Zn | 48 | <3 | 130 | 11 | 44 | <3 | 25 | 6.3 |

Source: USGS streamflow monitoring data.

[1] For concentrations reported to be below detection, a value of one-half the detection limit was used for calculating averages. For each constituent, detection limits may have varied between sampling events.

TDS = total dissolved solids; TSS = total suspended solids; NTU = nephelometric turbidity units.

n = number of concentration results available.

Min. = lowest value of available results.

Max. = highest value of available results.

Avg. = calculated average of available results (calculations used one-half the detection limit for non-detected values; if calculated average was less than the detection limit).

November). The average total phosphorus value near Rye Patch (0.09 mg/L as P) was less than the standard value (Table 3.2-20). Since phosphorous is typically associated with suspended particles in river flows, this result is consistent with the total suspended solids and turbidity results and likely reflects the settling of suspended particles in Rye Patch reservoir.

During the period of record, metal and semi-metal concentrations in the Humboldt River near Carlin and Rye Patch were typically near or below water quality standards (Table 3.2-20). In addition, most average constituent concentrations in the upstream river reach near Carlin were similar to average concentrations in the downstream reach near Rye Patch. The notable exceptions were arsenic and boron. Average arsenic concentrations increased from 7.2 µg/L near Carlin to 31 µg/L near Rye Patch. One dissolved arsenic measurement of 60 µg/L near Rye Patch exceeded the municipal or domestic supply standard of 50 µg/L. The average concentration of boron in the Humboldt River also increased from Carlin (150 µg/L) to Rye Patch (471 µg/L).

Humboldt Sink Water Quality. The Humboldt River terminates in the Humboldt Sink (Figure 1-6). The wetlands associated with the sink are characterized by extreme wet and dry cycles. From a historical perspective, prior to the upstream agricultural development, the wetland areas completely dried up during dry periods and spread out to encompass up to 20 square miles or more during wet periods. In addition, prior to agricultural development, the area of the wetlands is estimated to have averaged about 4.5 times greater than its present size (Seiler et al. 1993). Agricultural development resulted in the construction of dikes and drains along the lower Humboldt River that drained much of the wetlands for crops. Currently, the sink area consists of the Toulon Lake and upper and lower Humboldt Lakes. Water depths in the lakes typically range between 2 and 18 inches (Seiler et al. 1993).

The water quality of the Humboldt Sink wetland areas has been studied and monitored on an intermittent basis since 1987 jointly by the USGS and U.S. Fish and Wildlife Service (USGS 1991; Seiler et al. 1993; Seiler and Tuttle 1997). As stated in the 1993 report, these studies were initiated to "determine whether the quality of irrigation drainage in and near the Wildlife Management Area (WMA), Nevada, has caused or has potential to cause harmful effects on human health or fish and wildlife, or adversely affect the suitability of water for other beneficial uses" (Seiler et al. 1993). The studies concluded that arsenic, boron, mercury, molybdenum, sodium, un-ionized ammonia, selenium, and dissolved solids exceeded biological effects levels or Nevada standards for the protection of aquatic life. Causes of contamination were identified as irrigation drainage, hydrogeologic setting, and drought (Seiler et al. 1993; Seiler and Tuttle 1997). In addition, historic ore processing along the margin of the Humboldt Sink may be the source of some trace elements in the wetlands. Specifically, two mills located along the edge of what is now Toulon Lake operated from around 1915 through the 1920s. Both plants produced tungsten, and one later produced arsenic. Tailings from these operations could have been deposited or blown into what is now Toulon Lake (Seiler et al. 1993).

## 3.2.2 Environmental Consequences

The primary issues related to water resources include (1) reduction in surface and ground water quantity for current users and water-dependent natural resources due to mine-induced drawdown (mine dewatering and postmining pit lake development); (2) ground water or surface water quality impacts resulting from drawdown or infiltration; (3) water quality impacts associated with development of the pit lake in the postmining period; and (4) impacts to water quantity and water quality, flooding, erosion, and sedimentation in the Humboldt River resulting from direct mine discharge to the river. Impacts associated with mine drawdown, localized water management activities (such as infiltration), and postmining pit lake development are presented in Section 3.2.2.1; impacts to the Humboldt River resulting from discharge of excess mine water are addressed in Section 3.2.2.2.

### 3.2.2.1 Impacts from Mine Dewatering and Localized Water Management Activities

Hydrologic Study Area

The hydrologic study area for the assessment of impacts from mine dewatering and localized water management activities and pit lake development encompasses approximately 2,060 square miles and includes six designated ground water basins established by the Nevada Department of Water Resources (Figure 3.2-1). This hydrologic study area was selected to include the area potentially affected by drawdown and mounding and localized water management activities resulting from Barrick's Goldstrike Mine.

Dewatering and Infiltration Activities

The Goldstrike Mine dewatering and water management system components are described in Section 1.4. The Betze-Post Pit and Meikle Mine extend to depths below the regional ground water level. Dewatering is accomplished with a system of perimeter wells and in-pit wells, horizontal drains, and sumps designed to maintain water levels below the floor of the pit and underground mine as mining progresses.

Historic dewatering rates for the Goldstrike Mine through 1998 are presented in Figure 3.2-21 (Barrick 1999a). Ground water pumping for mine water supply was initiated at the Goldstrike Mine in 1987. Mine dewatering commenced in 1990 and will continue through the life of the Goldstrike Mine. Pumping rates have been variable and have ranged up to approximately 68,000 gpm (average rate for 3-month period). After active mining ceases, Barrick plans to continue pumping at a reduced rate for up to 10 years to provide for continued ore processing and reclamation activities. As of the end of 1998, a total volume of approximately 621,000 acre-feet of ground water had been pumped to achieve a maximum drawdown of over 1,500 feet (Table 3.2-21). Current plans are to continue to lower the ground water elevation in the vicinity of the mine to 3,576 feet amsl (drawdown of 1,689 feet). Once this target is reached, pumping would continue in order to maintain the ground water at the target elevation throughout the remaining mine life. At closure, the total pumped volume would be approximately 1,085,000 acre-feet with an estimated 645,000 acre-feet reinfiltrated to the ground water system through water management activities (including infiltration at ponds, injection, and infiltration during irrigation).

Impacts to Ground Water Levels

For this impact analysis, the area that is predicted to experience a change in ground water elevation of 10 feet or more from mine dewatering and mine water management activities was selected as the area of potential concern regarding impacts to water resources. Changes in the water table elevation of less than 10 feet generally were not considered in the analysis because these changes would probably be indistinguishable from natural seasonal and annual fluctuations in ground water levels.

**Impacts to Date (1991 – 1998).** Ground water levels have been closely monitored in the region surrounding the Goldstrike Mine. The monitoring results are presented in Barrick's Boulder Valley Monitoring Plan Quarterly Reports (Barrick 1999a) submitted to the Nevada State Engineer and the BLM. Areas of drawdown and mounding are determined by comparing the estimated and measured premine ground water elevations and the current ground water elevations measured at a series of monitoring wells.

The results of monitoring through the fourth quarter of 1998 were used to evaluate the ground water level changes to-date. As of the end of 1998, over 1,500 feet of drawdown had occurred in the vicinity of the Goldstrike Mine. As illustrated in Figure 3.2-22 (JBR 1990a; RTi 1994; Barrick 1999a), a cone of depression has formed around the project. The cone of depression exhibits a northwest-southeast elongation. In addition, the southwest margins of the cone appear to be controlled by one or more geologic barriers. The area with at least 10 feet of measured drawdown extends approximately 15 miles northwest-southeast and 5 miles northeast-southwest. Note that the 10-foot drawdown toward the south is not defined since Barrick's drawdown begins to merge or overlap with drawdown from Newmont's dewatering operations. This elongated northwest-oriented drawdown pattern is controlled in large part by removing water in storage within the

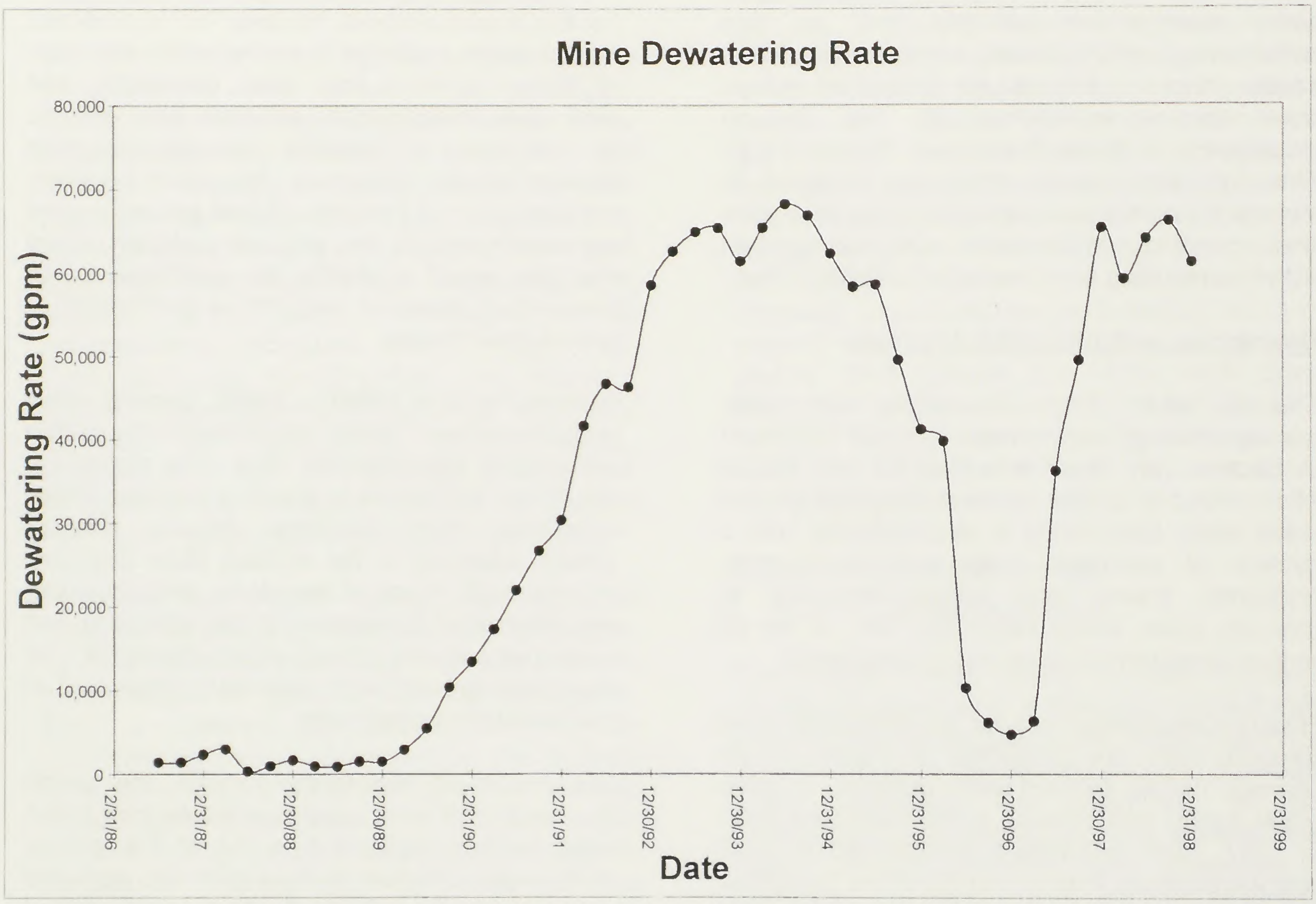

Figure 3.2-21

Barrick Pumping Rate

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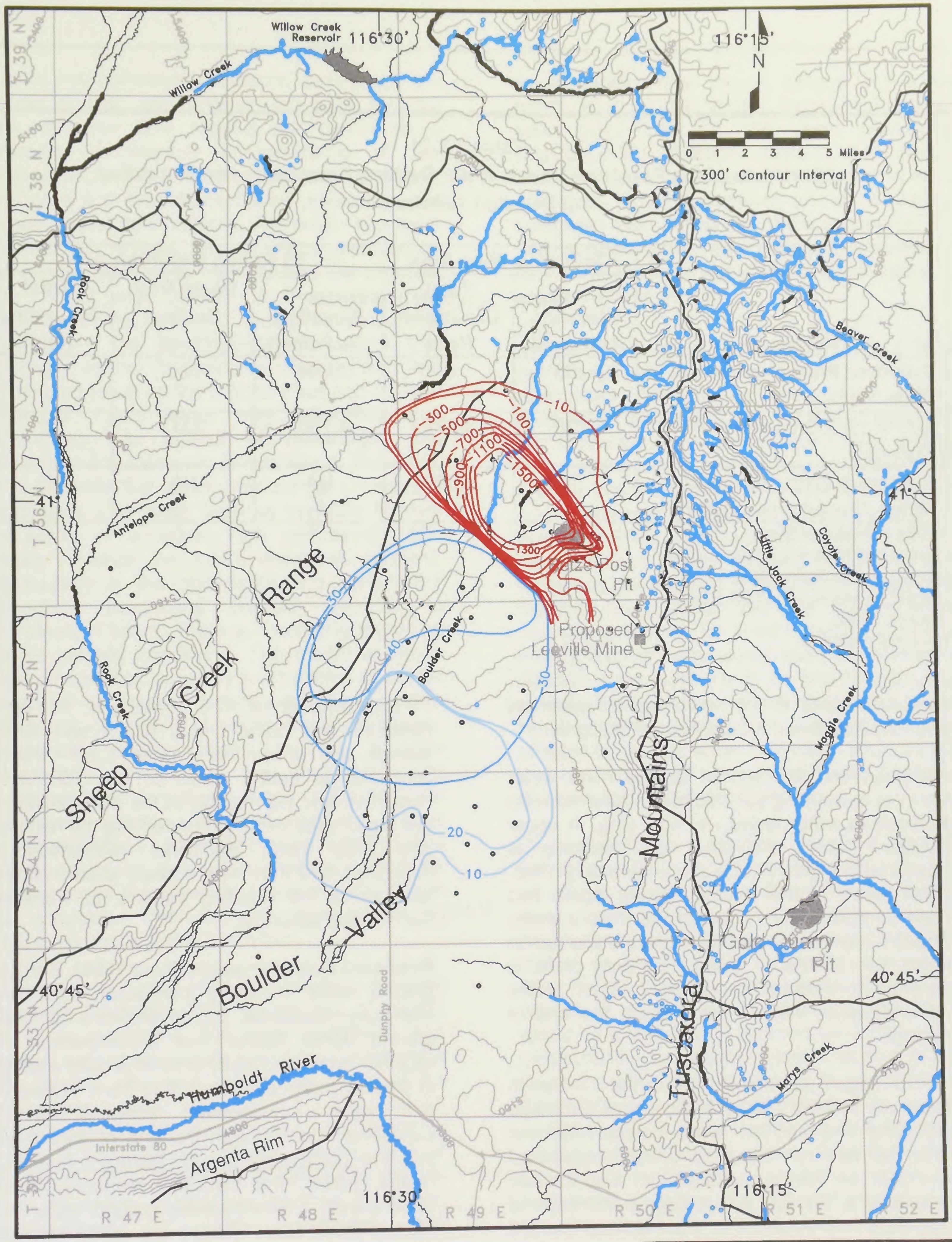

Legend

Stream (Intermittent and Ephemeral)

Road

Perennial Streams and Springs

Discontinuous Flowing Stream Reach ①

Springs and Seeps

Monitoring wells (Barrick Gold Mines Inc. 1999a)

Water Level Decline in Area of Pumping in Feet

Water Level Mounding in Area of Infiltration/Injection in Feet

Water Level Mounding in Area of Irrigation in Feet

① During baseflow these stream segments are characterized by discontinuous flowing and dry reaches.

Figure 3.2-22

Drawdown and Mounding, End of 1998

Table 3.2-21
Elevations of the Regional Ground Water System, Drawdown, and Mounding at Selected Timeframes

| Timeframe | Goldstrike Mine Area |  | TS Ranch Reservoir Area |  |  |
|---|---|---|---|---|---|
|  | Elevation (feet amsl) | Total Drawdown (feet) | Elevation (feet amsl) | Depth from Surface (feet) | Total Mounding (feet) |
| Estimated Premining Ground Water Surface | 5,265[1] | 0 | 4,704[2] | 383 | 0 |
| End of 1998 Ground Water Surface | 3,738[3] | 1,527 | 4,756[4] | 331[3] | 52 |
| Planned or Projected End of Mining Ground Water Surface | 3,576 | 1,689 | NA | NA | NA |

Source: Barrick 1999a.
[1] Based on Monitoring Wells SJ-144.
[2] Based on Monitoring Well NA-14.
[3] Based on Monitoring Wells PZ97-3.
[4] Barrick 1998c.
NA = not available.

carbonate rocks in the hydrologic compartment bounded between the Siphon and Post faults.

Infiltration and injection of excess mine water from the dewatering operations has resulted in an increase in water levels, or mounding, in upper Boulder Valley; this area of mounding is illustrated in Figure 3.2-22. As of the end of 1998, water levels in the Boulder Valley region had risen approximately 70 feet in the rhyolite in the Sheep Creek Range and 50 feet in the alluvium in upper Boulder Valley. Barrick currently plans to continue to infiltrate excess mine water in the upper Boulder Valley area through the end of mining.

Barrick began delivering water to the TS Ranch Reservoir in May 1990. Monitoring of discharge quantities and reservoir levels indicated that the reservoir was not filling as initially anticipated because of the appearance of the fracture described in Section 3.1. A large percentage of the water that flowed into the reservoir seeped through the fracture in the floor of the reservoir and flowed into the rhyolite formation. In 1992 and 1993, seepage from the reservoir apparently resulted in three new springs (Sand Dune, Knob, and Green springs) in the northeastern portion of Boulder Flat approximately 5 miles south of the TS Ranch Reservoir. The locations of TS Ranch Reservoir and Sand Dune, Knob, and Green springs are shown in Figure 3.2-1. Barrick continued to deliver water to the TS Ranch Reservoir, and the majority of the water infiltrated into the rhyolite formation underlying the reservoir until early 1996. Additional information on monitored flow from new springs is summarized later under the heading Impacts to Perennial Springs and Streams.

**Predicted Future Impacts (Post-1998).** Barrick's ground water modeling contractor, McDonald Morrissey Associates, Inc. developed a numerical ground water model that encompasses the regional hydrologic study area to predict changes in ground water levels resulting from dewatering and water management activities at the Goldstrike Mine through the end of mining and into the postmining period. Barrick's numerical model uses the USGS modular, three-dimensional, finite-difference ground water flow model MODFLOW (McDonald and Harbaugh 1988) to simulate mine dewatering and water management activities. The model design, modifications, calibration, simulations, and sensitivity analyses are presented in McDonald Morrissey Associates, Inc. (1998) and are summarized in Appendix D.

Actual hydrogeologic conditions throughout the model domain are complex; however, regional ground water flow models are based on a simplified conceptual understanding of the hydrostratigraphic and hydrostructural conditions, recharge and evapotranspiration processes, and ground water flow patterns. The model has been substantially revised, refined, and recalibrated on an annual basis since 1990. During this process, the model was revised to incorporate new hydrologic information. It should be noted that several of the key hydrologic features that currently control the patterns of drawdown and mounding (such as the Siphon Fault and Boulder Narrows Fault) were only identified after monitoring the effects of dewatering and infiltration activities over several years. Therefore, it is possible that other unknown or undetected conditions may exist, such as hydraulic barriers or zones of unusually high permeability, that could influence the future drawdown patterns, particularly in the post-dewatering period. For long-term predictions (several decades to hundreds of years), there is uncertainty regarding future climatic conditions. The model assumed that precipitation amounts and patterns observed over the last several decades are representative of future conditions. Despite these limitations, numerical models based on an accurate conceptual model of the hydrologic and hydrogeologic system, and calibrated to monitored steady state and transient ground water elevations, represent the best available tool for predicting the general areal extent, magnitude, and timing of drawdown and recovery that should be anticipated from Barrick's mine dewatering and water management activities.

Simulations of mine-induced drawdown resulting from the Goldstrike Mine for the end of mining, 50 years postmining, 100 years postmining, and at final steady state were evaluated to determine the relative maximum extent and timing of the drawdown cone (Figures 3.2-23, 3.2-24, 3.2-25, and 3.2-26, respectively). As shown in Figure 3.2-23 (Barrick 1998c), at the end of mining the drawdown area as defined by the 10-foot drawdown contour is predicted to extend approximately 7 miles northwest and approximately 12 miles south-southeast from the center of the Betze-Post Pit. Comparison of the three postmining periods indicates that the maximum extent of the 10-foot drawdown contour would expand after mining ceases and would reach a maximum extent approximately 100 years postmining. At 100 years postmining (Figure 3.2-25) (Barrick 1998c), the 10-foot drawdown contour is predicted to extend 11 miles northwest, 15 miles southeast, and up to 12 miles southwest from the center of the Betze-Post Pit. The expansion of the area of drawdown results in part from continual long-term passive inflow of ground water to the pit.

As described previously, in prior years a large percentage of the excess mine water was reinfiltrated into the ground water system because of seepage at the TS Ranch Reservoir and infiltration ponds and injection wells located in the northern portion of the Boulder Valley area. A water treatment and conveyance structure also was constructed to discharge excess water to the Humboldt River. The latter substantially reduced the amount of water infiltrating the rhyolite and alluvial aquifer systems in the Boulder Valley area through 1998. Under Barrick's current water management plans for 1999 through the end of mining, excess water would again be allowed to infiltrate to the rhyolite bedrock and alluvium, and no additional water would be discharged to the Humboldt River. Under this scenario, the area affected by ground water mounding would persist through the end of mining and would gradually dissipate in the postmining period.

Once dewatering operations cease, a pit lake would begin to develop in the Betze-Post Pit. The pit lake is predicted to attain 95 percent steady state (or equilibrium) conditions (Radian International, LLC and Baker Consultants, Inc. 1997a) at approximately 233 years postmining. After the pit lake level reaches equilibrium, the numerical ground water model predicts there would be a long-term drawdown cone that would persist for the foreseeable future. The area of this long-term residual drawdown, as shown in Figure 3.2-26 (Barrick 1998c), is predicted to extend approximately 7 miles northwest and 11 miles south-southeast from the center of the Betze-Post Pit. This permanent drawdown would be maintained by continuous inflow of ground water into the pit lake to replace water lost through evaporation (net loss of approximately 2,700 gpm).

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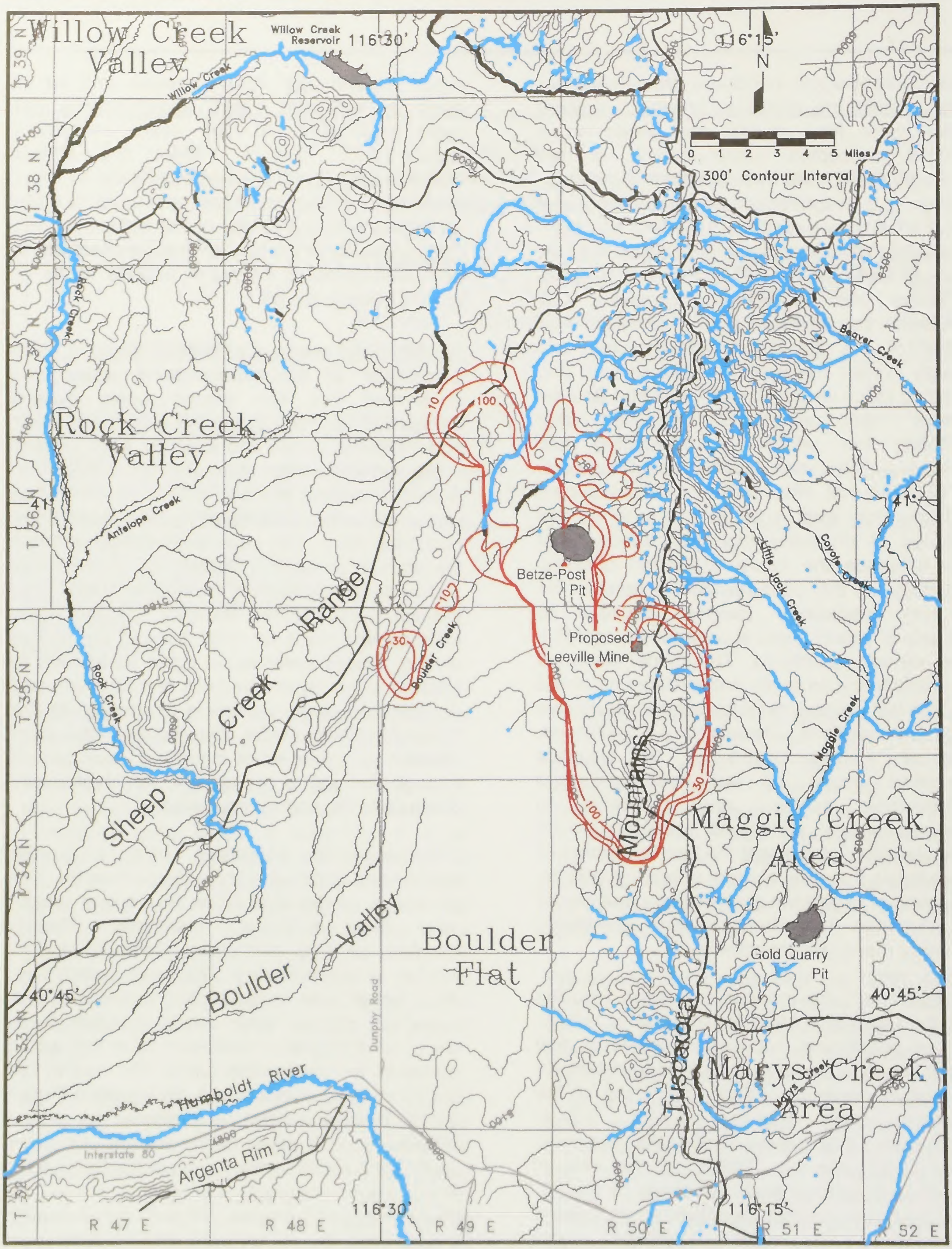


Legend

Stream (Intermittent or Ephemeral)

Road

Perennial Streams and Springs

Discontinuous Flowing Stream Reach ①

Contour of Drawdown in Feet

Ground Water Basin Boundary

• Springs and Seeps

① During baseflow these stream segments are characterized by discontinuous flowing and dry reaches.

Figure 3.2-23

Predicted Drawdown at End of Mining

\A305\DWG\30500.DWG [Layer on: dd2061*] REVISION: 3/17/2000 [305dd50.plt]

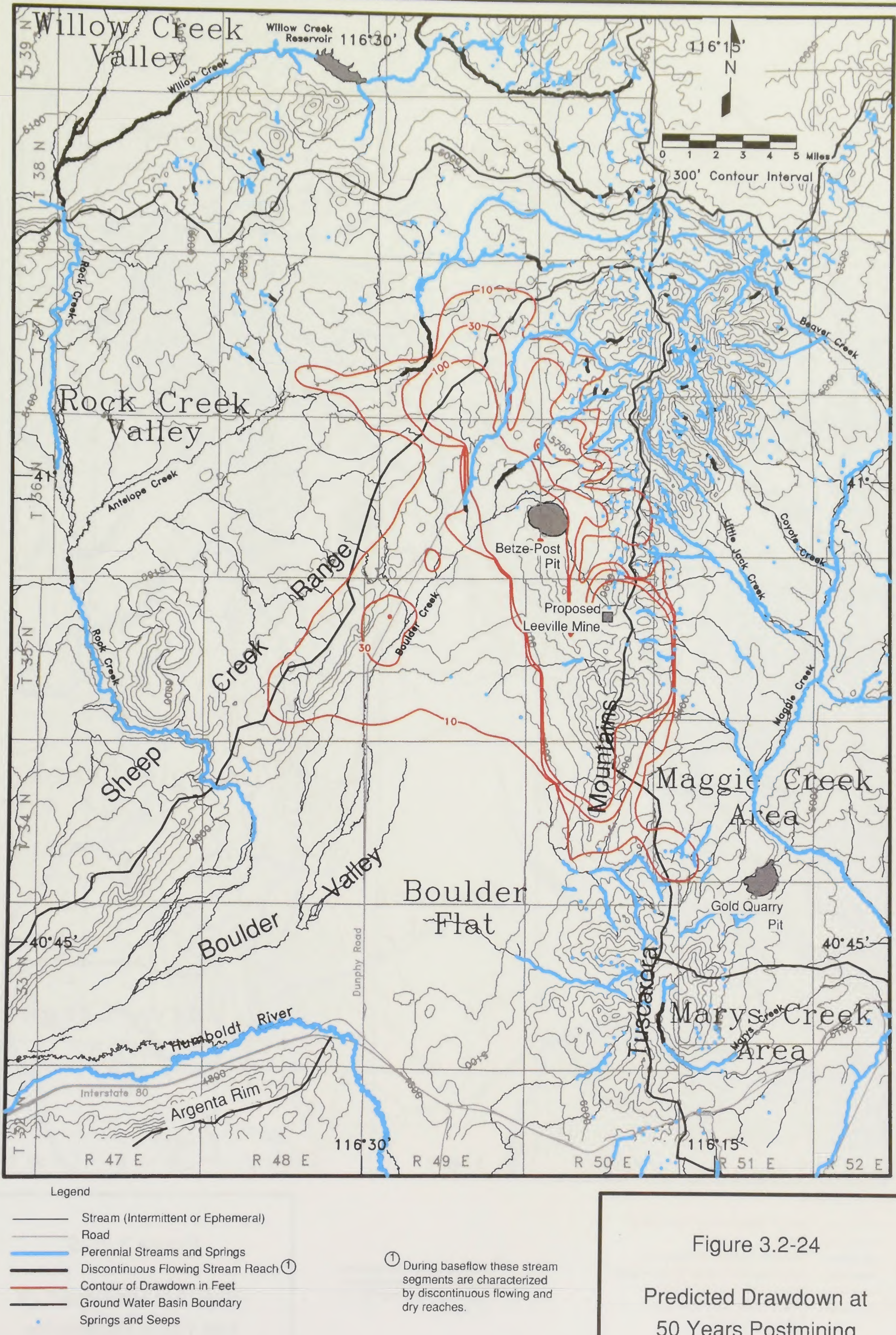
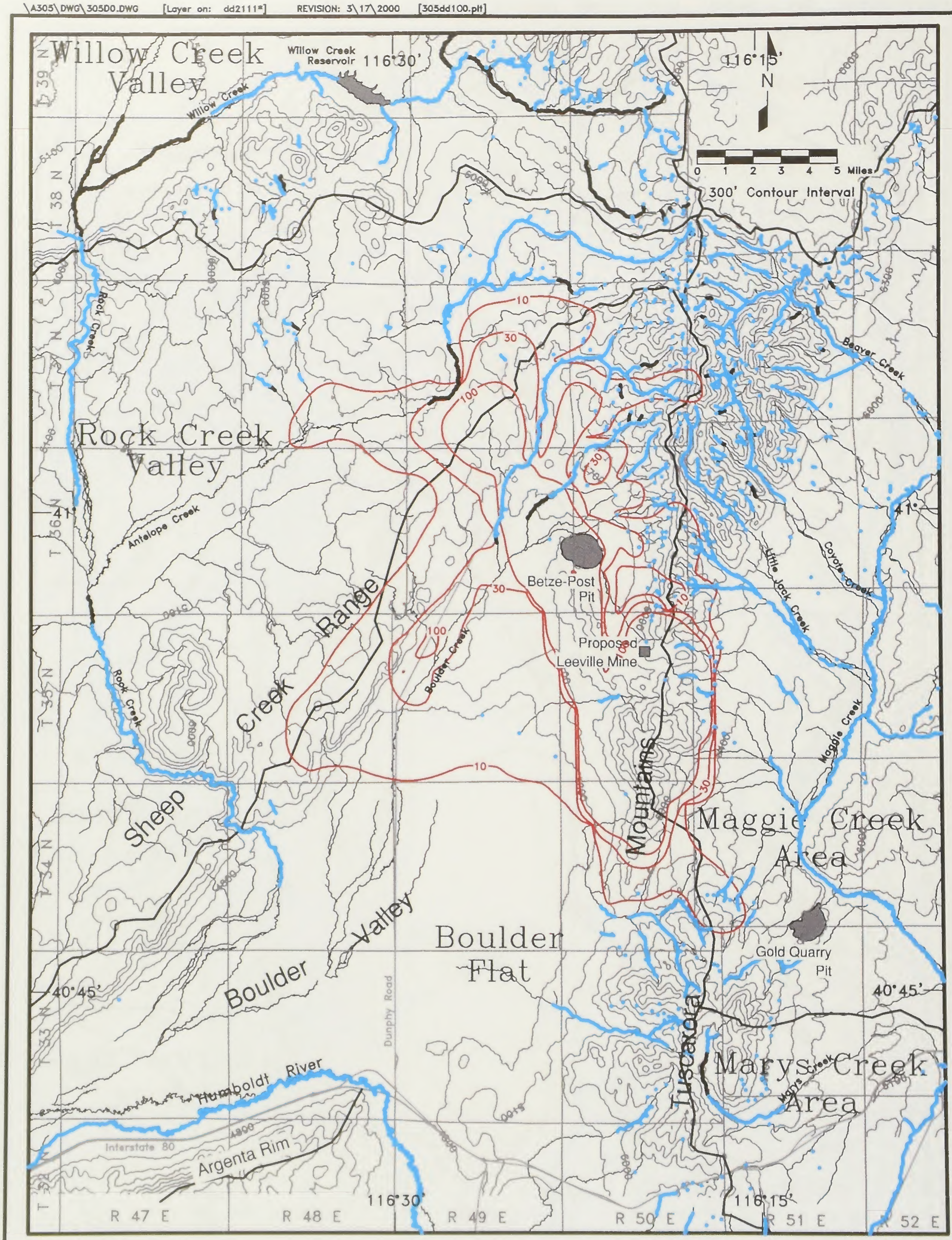


Figure 3.2-24

Predicted Drawdown at 50 Years Postmining

\A305\DWG\305D0.DWG [Layer on: dd2111*] REVISION: 3\17\2000 [305dd100.plt]



Legend

Stream (Intermittent or Ephemeral)

Road

Perennial Streams and Springs

Discontinuous Flowing Stream Reach ①

Contour of Drawdown in Feet

Ground Water Basin Boundary

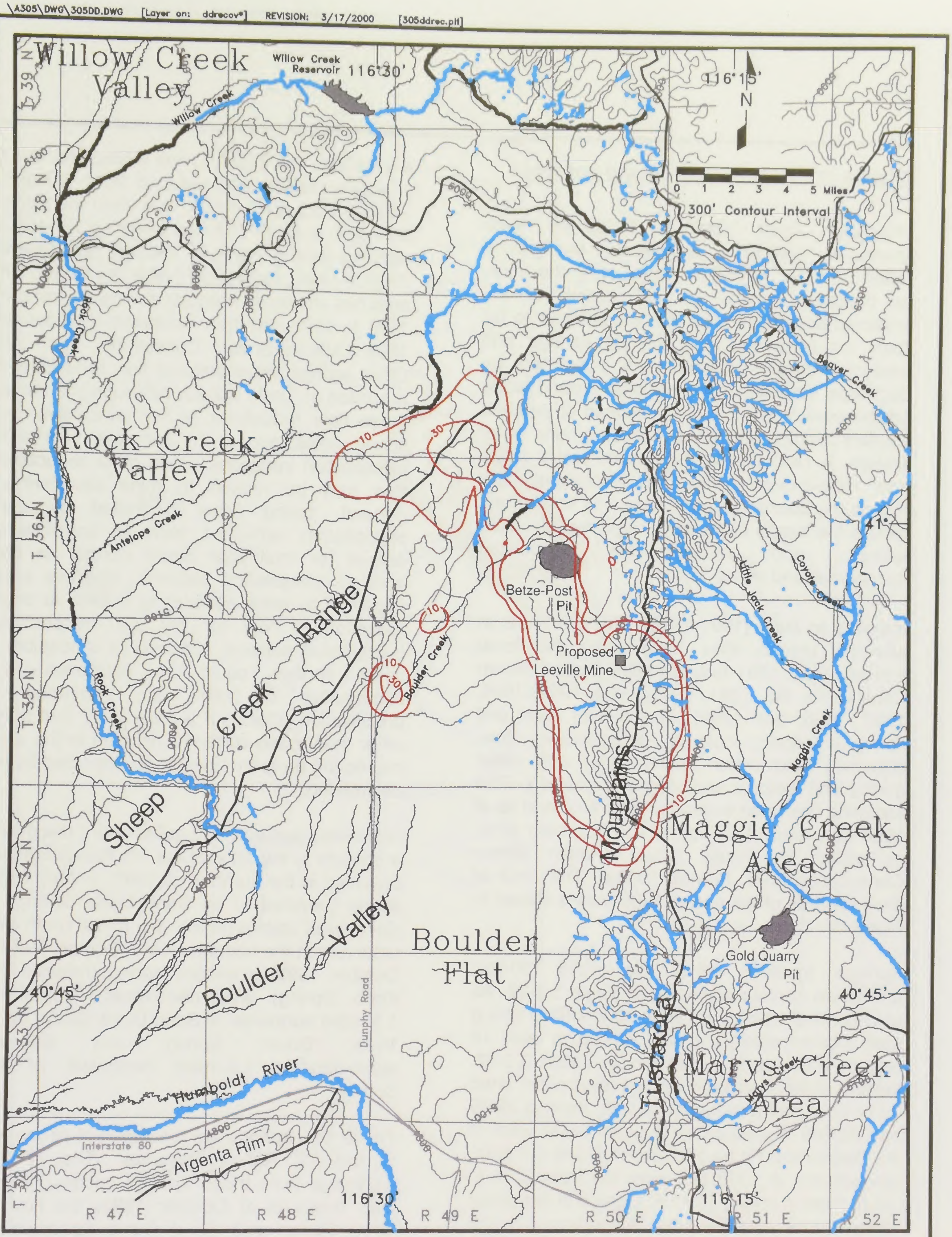
Springs and Seeps

① During baseflow these stream segments are characterized by discontinuous flowing and dry reaches.

Figure 3.2-25

Predicted Drawdown at 100 Years Postmining

\A305\DWG\305DD.DWG [Layer on: ddrecov*] REVISION: 3/17/2000 [305ddrec.plt]



Legend

| | |
|---|---|
| ─ | Stream (Intermittent or Ephemeral) |
| ─ | Road |
| ─ | Perennial Streams and Springs |
| ━ | Discontinuous Flowing Stream Reach ① |
| ─ | Contour of Drawdown in Feet |
| ─ | Ground Water Basin Boundary |
| • | Springs and Seeps |

① During baseflow these stream segments are characterized by discontinuous flowing and dry reaches.

Figure 3.2-26

Predicted Drawdown at Recovery

## Impacts to Perennial Springs and Streams

Drawdown from Barrick's Goldstrike Mine dewatering operations is lowering the ground water levels in the region surrounding the mine, as described above. In the vicinity of the projected drawdown area, the late summer to fall flows (or baseflow) in individual springs and perennial stream reaches are supported by discharge from either the regional ground water aquifer system or from more isolated or perched aquifers residing above the regional ground water system. A reduction in the ground water levels from mine-induced drawdown could potentially reduce the discharge to the perennial source and reduce the length of perennial reaches, eliminate springs, and reduce the associated riparian/wetland areas.

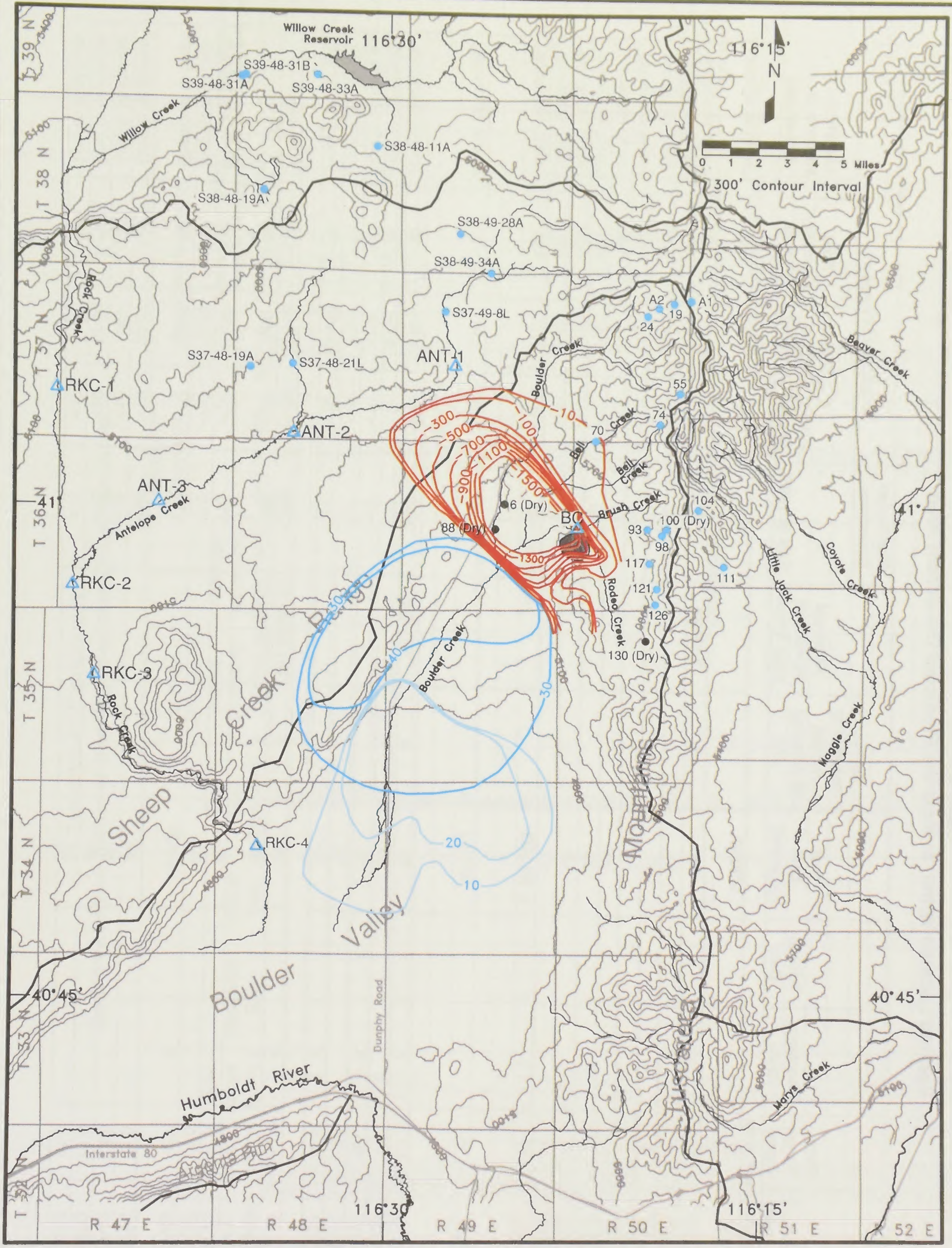
**Impacts to Date (1991-1998)**. The conditions at selected stream sites have been monitored annually from 1991 through 1998 (Adrian Brown Consultants, Inc. 1991, 1993, 1994, 1995, 1996, 1997, 1998, and 1999). The annual seep and spring monitoring consists of measuring flow, collecting field water quality data, and water quality and isotopic sampling and analysis. This sampling has been expanded over time and as of 1998 consisted of 28 spring and 8 stream sites, as shown in Figure 3.2-27 (Adrian Brown Consultants 1999; Barrick 1999a). The area of drawdown as of the end of 1998 also is shown in Figure 3.2-22.

Springs located within the 1998 10-foot drawdown contour are listed in Table 3.2-22. As of the end of 1998, there were 13 identified spring sites located within the area having at least 10 feet of drawdown. As shown in Table 3.2-22, several of the monitored springs have either dried up or have had a reduction in flow. Springs JBR6 and JBR88 located along Boulder Creek west of the Betze-Post Pit had flows of 1.5 and 0.5 gpm, respectively, in 1989, but were dry from 1995 to 1998. Flow in spring JBR130 located in the upper Rodeo Creek watershed diminished from 4.3 gpm in 1989 to zero during the 1993 to 1998 monitoring period. The drying up of these three springs was probably caused by mine dewatering activities. Several other springs located both within and outside of the 1998 10-foot drawdown area have shown a reduction in flow. For example, in the Brush Creek watershed, the flow in spring JBR98 was reduced from 0.5 gpm in 1995 to 0.03 gpm in 1997 and then increased to 0.47 gpm in 1998. The flow of spring JBR100 was reduced from 0.2 gpm in 1991 to zero flow from 1995 to 1998. Spring JBR126 in the Rodeo Creek area has shown an irregular downward trend from 1991 to 1997 and then increased substantially in 1998 (Adrian Brown Consultants, Inc. 1999). Other springs with monitored flow reductions also are listed in Table 3.2-22. Although the cause of these flow reductions is not conclusive, some spring flows appear to correlate with annual precipitation variations, while other reductions in flow may be related to mine dewatering. In general, spring flows controlled by annual precipitation variations tend to correlate with annual (or multi-year below normal or above normal) precipitation patterns, whereas springs impacted by mine dewatering appear to show a reduction of flow (or dry up) irrespective of precipitation patterns. However, it is possible that some springs could be controlled by a combination of both mine drawdown and precipitation effects. It is also likely that springs other than those currently included in the annual monitoring program have been impacted by mine dewatering.

Noticeable leakage and subsequent discovery of a fracture in the floor of the TS Ranch Reservoir occurred in the summer of 1990. In May 1992, a spring (referred to as Sand Dune Spring) was discovered approximately 5.5 miles south of the reservoir on the eastern side of Boulder Valley. In October 1992, a second spring (referred to as Knob Spring) was discovered approximately 1.5 miles northwest of Sand Dune Spring. In April 1993, Green Spring was discovered approximately 1.5 miles northwest of Knob Spring.

These new springs are the result of seepage out of the TS Ranch Reservoir. The combined discharge from these springs initially increased over time. As of October 1993, the flow from Knob Spring and Sand Dune Spring merged approximately 1.5 miles downstream from where they first appeared. The combined spring discharge then flowed several miles farther downstream before the water infiltrated the alluvium in lower Boulder Valley. Green Spring

\A305\DWG\305ad98.DWG [Layer on: BVMPDEC98*] REVISION: 3/17/2000



Legend

| | |
|---|---|
| — | Stream |
| — | Road |
| — | Ground Water Basin Boundary |
| ●130 | Spring and Seep Sampling Site① |
| RKC-4 △ | Surface Water Monitoring Sites② |
| — | Water Level Decline in Area of Pumping in Feet |
| — | Water Level Mounding in Area of Infiltration/Injection in Feet |
| — | Water Level Mounding in Area of Irrigation in Feet |

① Adrian Brown's spring and seep monitoring site locations were modified according to JBR Consultants Group 1990a, and Riverside Technology, inc. 1994 spring locations.

② Adrian Brown's surface water monitoring site locations were modified according to Barrick Goldstrike Mines Inc. 1999a surface water sampling locations.

Figure 3.2-27

1998 Drawdown Relative to Annual Spring and Stream Monitoring Sites

## Table 3.2-22
## Springs Located Within or Near the Predicted Drawdown Area[1,2]

| Spring and Surface Water Monitoring Site | Elev. (ft-amsl) | Flow Range (gpm) | Geochem. Data | Tritium Data | Year Last Measured | Springs Included in Annual Monitoring (X) | Apparent Monitored Flow Trend | Monitoried Drawdown | Predicted Drawdown | | | Likelihood of Impacts From Drawdown |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | End of 1998 | End of Mining | 100-Yr Post-mining | Post Recovery Period | |
| ***Upper Antelope Creek / Squaw Creek Area*** | | | | | | | | | | | | |
| SW37-49-08A (Antelope Creek) | 5400 | 22 | | | 9/30/93 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| S37-49-8L | 5420 | 172-0 | X | X | 98 | X | Variable | <10 | <10 | <10 | <10 | Low to Moderate |
| S37-49-8B | 5460 | <1 | | | 93 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| S37-49-8A | 5460 | 4 | | | 93 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| S37-49-5C | 5460 | 1 | | | 93 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| S37-49-5A | 5460 | 1-5 | | | 93 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| S37-49-5B | 5460 | 1 | | | 93 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| S38-49-33M | 5530 | <1 | | | 93 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| S38-49-33L | 5580 | <1 | | | 93 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| SW37-50-05A (Antelope Creek below Squaw Creek Confluence) | 5540 | 17 | | | 9/30/93 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| SW37-50-05B (Squaw Creek at confluence with Antelope Creek) | 5550 | 20 | | | 10/1/93 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| S38-49-34A | 5600 | 4.8-0.36 | X | X | 98 | X | Variable | <10 | <10 | <10 | <10 | Low to Moderate |
| S37-49-3A | 5600 | <1 | | | 93 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| S38-49-34L | 5600 | NA | X | X | 93 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| JBR7 | 6200 | 1.95 | | | 89 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| S37-49-15L | 5800 | 32.6 | X | | 93 | | | <10 | <10 | 30-100 | ~10 | Moderate to High |
| ***Boulder Creek Area*** | | | | | | | | | | | | |
| JBR88 | 5400 | 0.5-Dry | X | | 98 | X | Dry Since 92 | >1500 | 10-30 | 30-100 | <10 | High |
| JBR6 | 5400+B 42 | 1.5-Dry | X | | 98 | X | Dry Since 92 | >1500 | >100 | >100 | >30 | High |
| JBR5 | 5720 | <1.0 | | | 89 | | | <10 | <10 | 10-30 | <10 | Moderate to High |
| JBR4 | 5680 | <1.0 | | | 89 | | | <10 | <10 | 10-30 | <10 | Moderate to High |
| SW37-49-24A (Upper Boulder Creek) | 5680 | 45 | X | | 10/3/93 | | | <10 | <10 | 10-30 | <10 | Moderate to High |
| JBR3 | 5720 | <1.0 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low to Moderate |
| JBR2 | 5860 | 1.53 | | | 89 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| JBR1 | 5900 | <1.0 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low to Moderate |
| JBR32 | 5940 | <1.0 | | | 89 | | | <10 | <10 | <10 | <10 | Low to Moderate |

## Table 3.2-22 (Continued)
## Springs Located Within or Near the Predicted Drawdown Area[1,2]

| Spring and Surface Water Monitoring Site | Elev. (amsl) (ft) | Flow Range (gpm) | Geochem. Data | Tritium Data | Year Last Measured | Springs Included in Annual Monitoring (X) | Apparent Monitored Flow Trend | Monitored Drawdown | Predicted Drawdown | | | Likelihood of Impacts From Drawdown |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | End of 1998 | End of Mining | 100-Yr Post Mining | Post Recovery Period | |
| JBR31 | 6040 | <1.0 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| JBR30 | 6040 | <1.0 | | | 89 | | | <10 | <10 | ~10 | <10 | Low |
| JBR29 | 6080 | <1.0 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low |
| JBR28 | 6230 | 0 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low |
| JBR47 | 6280 | <1.0 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| JBR48 | 6700 | <1.0 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low |
| S37-50-28L (JBR-49) | 5960 | 0.8 | X | | 93 | | | <10 | <10 | 10-30 | <10 | Low |
| JBR50 | 6720 | <1.0 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| JBR51 | 6700 | 3 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low |
| JBR52 | 6840 | 1 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low |
| JBR53 | 6920 | 4 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low |
| JBR54 | 7120 | <1.0 | | | 89 | | | <10 | <10 | ~10 | <10 | Low |
| JBR55 | 7220 | 26.9-0.5 | X | X | 98 | X | Variable | <10 | <10 | ~10 | <10 | Low |
| JBR43 | 7600 | <1.0 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| JBR44 | 7680 | <0.25 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| S37-50-15A (JBR45) | 7120 | 1-0.23 | X | | 93 | | | <10 | <10 | <10 | <10 | Low |
| JBR46 | 7000 | 1.8 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| JBR56 | 7160 | <1.0 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| ***Bell Creek Area*** | | | | | | | | | | | | |
| JBR71 | 5550 | 1.2 | X | | 89 | | | 10-100 | 10-30 | 10-30 | <10 | Moderate |
| JBR72 | 5560 | 0.3 | | | 89 | | | 10-100 | 10-30 | 10-30 | <10 | Moderate |
| JBR70 | 5740+B72 | 33.6-4.95 | X | X | 98 | X | No Reduction | 10-100 | 10-30 | 10-30 | <10 | Moderate |
| JBR69 | 5780 | 0 | | | 89 | | | 10-100 | 10-30 | 10-30 | <10 | Moderate |
| JBR68 | 6040 | 0.3 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low to Moderate |
| JBR67 | 6020 | 22 | | | 89 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| JBR66 | 6080 | 3.15 | | | 89 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| JBR63 | 6100 | <1.0 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low to Moderate |
| JBR62 | 6160 | 0.3 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low to Moderate |
| JBR65 | 6120 | 1.5 | | | 89 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| JBR64 | 6320 | 0 | | | 89 | | | <10 | <10 | <10 | <10 | Low to Moderate |
| S37-50-29A(JBR61) | 6320 | <1.0-0.6 | X | | 93 | | | <10 | <10 | 10-30 | <10 | Low |
| JBR60 | 6360 | <1.0 | | | 89 | | | <10 | <10 | 30-100 | <10 | Low |
| JBR58 | 6400 | - | | | 89 | | | <10 | <10 | <10 | <10 | Low |

## Table 3.2-22 (Continued)
## Springs Located Within or Near the Predicted Drawdown Area[1,2]

| Spring and Surface Water Monitoring Site | Elev. (amsl) (ft) | Flow Range (gpm) | Geochem. Data | Tritium Data | Year Last Measured | Springs Included in Annual Monitoring (X) | Apparent Monitored Flow Trend | Monitored Drawdown | Predicted Drawdown | | | Likelihood of Impacts From Drawdown |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | End of 1998 | End of Mining | 100-Yr Post Mining | Post Recovery Period | |
| JBR59 | 6640 | 0.5 | X | | 89 | | | <10 | <10 | 10-30 | <10 | Low |
| S37-50-27A (JBR57) | 6960 | 0.6 | X | | 93 | | | <10 | <10 | <10 | <10 | Low |
| ***Brush Creek Area*** | | | | | | | | | | | | |
| JBR73 | 5680 | 1.05 | | | 89 | | | <10 | 10-30 | 10-30 | <10 | Moderate to High |
| JBR90 | 5550 | 0.5 | X | | 89 | | | <10 | <10 | ~10 | <10 | Moderate to High |
| JBR91 | 5700 | 0.42 | | | 89 | | | <10 | 10-30 | 30-100 | <10 | Moderate to High |
| JBR93 | 5920 | 5-0.0 | X | X | 98 | X | Variable | <10 | <10 | 10-30 | <10 | Moderate to High |
| JBR92 | 5920 | 0.5 | X | | 89 | | | <10 | <10 | 10-30 | <10 | Moderate to High |
| JBR96 | 5940 | <1.0 | X | | 89 | | | <10 | <10 | 10-30 | <10 | Moderate to High |
| JBR82 | 6000 | 7.5 | | | 89 | | | <10 | <10 | <10 | <10 | Moderate to High |
| JBR94 | 6040 | 0.5 | X | | 89 | | | <10 | <10 | 10-30 | <10 | Moderate to High |
| JBR80 | 6040 | 1.35 | | | 89 | | | <10 | <10 | <10 | <10 | Moderate to High |
| JBR83 | 6160 | 2.55 | X | | 89 | | | <10 | <10 | <10 | <10 | Moderate to High |
| JBR81 | 6200 | 1.58 | | | 89 | | | <10 | <10 | <10 | <10 | Moderate to High |
| JBR97 | 6220 | <1.0 | | | 89 | | | <10 | <10 | 10-30 | <10 | Moderate to High |
| JBR98 | 6240 | 0.5-0.03 | X | X | 98 | X | Variable | <10 | <10 | 10-30 | <10 | Moderate to High |
| JBR99 | 6360 | <1.0 | | | 89 | | | <10 | <10 | 10-30 | <10 | Moderate to High |
| JBR101 | 6260 | 4.0-1.2 | X | | 91 | | | <10 | <10 | 10-30 | <10 | Moderate to High |
| JBR100 | 6440 | 0.2-dry | X | X | 98 | X | No flow since 95 | <10 | <10 | 10-30 | <10 | High |
| JBR102 | 6460 | 0.5 | X | | 89 | | | <10 | <10 | 10-30 | <10 | Moderate |
| JBR84 | 6400 | 0.6 | | | 89 | | | <10 | <10 | <10 | <10 | Moderate |
| JBR85 | 6520 | 0.3 | | | 89 | | | <10 | <10 | <10 | <10 | Moderate |
| JBR86 | 6650 | 1 | | | 89 | | | <10 | <10 | 10-30 | <10 | Moderate |
| ***Rodeo Creek Area*** | | | | | | | | | | | | |
| JBR89 | 5220 | <1.0 | | | 89 | | | >1500 | >100 | >100 | >30 | High |
| JBR95 | 5780 | <1.0 | | | 89 | | | <10 | 10-30 | 30-100 | <10 | Moderate to High |
| JBR117 | 5960 | 1.3-<0.1 | X | X | 98 | X | Variable | <10 | <10 | 10-30 | <10 | Moderate to High |
| S36-50-35A (JBR120) | 5960 | 2.0-1.6 | X | | 93 | | | <10 | <10 | <10 | <10 | Moderate to High |
| JBR116 | 6000 | 0.5 | X | | 89 | | | <10 | <10 | 10-30 | <10 | Moderate to High |
| JBR115 | 6080 | - | | | 89 | | | <10 | <10 | 10-30 | <10 | Moderate to High |
| JBR128 | 6300 | 4.0 | | | 89 | | | 100-300 (a) | 30-100 | >100 | 10-30 | Moderate to High |
| S35-50-2A (JBR129) | 6280 | 3-1.9 | X | | 93 | | | 300-500 (a) | 30-100 | >100 | >30 | Moderate to High |
| JBR130 | 6100 | 4.3-Dry | X | X | 98 | X | Dry since 93 | 300-500 (a) | >100 | >100 | >30 | High |
| JBR118 | 6260 | 0.5 | X | | 89 | | | <10 | <10 | <10 | <10 | Moderate to High |
| JBR126 | 6250 | 1.4-0.09 | X | X | 98 | X | Variable | 10-100 (a) | 10-30 | 30-100 | <10 | Moderate to High |

## Table 3.2-22 (Continued)
## Springs Located Within or Near the Predicted Drawdown Area$^{1,2}$

| Spring and Surface Water Monitoring Site | Elev. (amsl) (ft) | Flow Range (gpm) | Geochem. Data | Tritium Data | Year Last Measured | Springs Included in Annual Monitoring (X) | Apparent Monitored Flow Trend | Monitored Drawdown | Predicted Drawdown | | | Likelihood of Impacts From Drawdown |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | End of 1998 | End of Mining | 100-Yr Post Mining | Post Recovery Period | |
| JBR125 | 6280 | 1 | | | 89 | | | 10-100 (a) | ~10 | 30-100 | <10 | Moderate to High |
| JBR122 | 6320 | <1.0 | | | 89 | | | <10 | <10 | <10 | <10 | Moderate to High |
| JBR124 | 6320 | 3 | | | 89 | | | <10 | <10 | <10 | <10 | Moderate to High |
| JBR121 | 6200 | 1.4-<0.1 | X | X | 98 | X | Reduction since 96 | <10 | <10 | <10 | <10 | High |
| JBR127 | 6380 | 0.45 | | | 89 | | | 10-100 (a) | ~10 | ~30 | <10 | Moderate to High |
| JBR119 | 6400 | <1.0 | | | 89 | | | <10 | <10 | <10 | <10 | Moderate to High |
| JBR123 | 6400 | <1.0 | | | 89 | | | <10 | <10 | <10 | <10 | Moderate to High |
| ***East Slope Tuscarora (Maggie Creek Drainage Area)*** | | | | | | | | | | | | |
| S35-51-32L | 5560 | NA | X | X | 93 | | | (b) | <10 | <10 | <10 | Low |
| S35-51-30L | 5560 | 0.4 | X | | 93 | | | (b) | 30-100 | ~30 | 10-30 | Low |
| NGC 56 | ~5600 | Dry | | | 98 | X | Dry | (b) | >100 | >100 | >30 | Low |
| S35-51-19A | 5760+B 125 | 1.1 | X | | 93 | | | (b) | >100 | >100 | >30 | Low |
| S35-51-19B | 5700 | 1.6 | | | 93 | | | (b) | >100 | >100 | >30 | Low |
| NGC 55 | ~5800 | 1.44-dry | | | 98 | X | Dry in Fall | (b) | ~10 | ~30 | <10 | Low |
| NGC 1 | ~6200 | 59-0 | X | | 98 | X | Dry in Fall | (b) | >100 | >100 | >30 | Low |
| NGC 54 | ~5890 | 8.1-dry | | | 98 | X | Dry in Fall | (b) | ~30 | ~100 | 10-30 | Low |
| S35-51-18A | 5880 | <1.0 | X | | 93 | | | (b) | <10 | 10-30 | <10 | Low |
| S35-50-12L (JBR131) | 6200 | 1.1 | X | | 93 | | | (b) | ~100 | >100 | >30 | Low |
| JBR114 | 6180 | 1.2 | | | 89 | | | <10 | <10 | ~10 | <10 | Low |
| JBR113 | 5840 | <1.0 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| S36-50-25A | 6400 | 0.6 | X | | 93 | | | <10 | <10 | 10-30 | <10 | Low |
| S36-51-30A (JBR109) | 5950 | 14-7 | X | | 93 | | | <10 | <10 | <10 | <10 | Low |
| JBR110 | 6200 | <1 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| JBR107 | 6250 | 2 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low |
| JBR108 | 6280 | <1 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| JBR105 | 6560 | <1 | | | 89 | | | <10 | <10 | 10-30 | <10 | Low |
| JBR106 | 6320 | <1 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| JBR103 | 6520 | <1 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| JBR104 | 6390 | 7.5-0.5 | X | X | 98 | X | | <10 | <10 | <10 | <10 | Low |
| JBR87 | 6600 | <1 | | | 89 | | | <10 | <10 | <10 | <10 | Low |
| S37-50-27L | 7400 | 1.3 | | | 93 | | | <10 | <10 | <10 | <10 | Low |
| S37-50-27M | 7600 | 1.4 | | | 93 | | | <10 | <10 | <10 | <10 | Low |
| S37-51-31L | 7400 | 0.6 | X | | 93 | | | <10 | <10 | <10 | <10 | Low |
| S37-51-29B | 7800 | 3.7 | X | | 93 | | | <10 | <10 | <10 | <10 | Low |

## Table 3.2-22 (Continued)
## Springs Located Within or Near the Predicted Drawdown Area[1,2]

| Spring and Surface Water Monitoring Site | Elev. (amsl) (ft) | Flow Range (gpm) | Geochem. Data | Tritium Data | Year Last Measured | Springs Included in Annual Monitoring (X) | Apparent Monitored Flow Trend | Monitored Drawdown | Predicted Drawdown | | | Likelihood of Impacts From Drawdown |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | End of 1998 | End of Mining | 100-Yr Post Mining | Post Recovery Period | |
| S37-51-30B | 7800 | 1.3 | | | 93 | | | <10 | <10 | <10 | <10 | Low |
| S37-51-29A | 7380 | 1.8 | | | 93 | | | <10 | <10 | <10 | <10 | Low |
| S37-51-30A | 7450 | <1 | | | 93 | | | <10 | <10 | <10 | <10 | Low |
| ***West Flank of Richmond Mountain*** | | | | | | | | | | | | |
| S34-50-4A | 5150 | <1.0 | X | | 93 | | | (b) | >100 | >100 | >30 | Moderate to High |
| ***Welches Canyon*** | | | | | | | | | | | | |
| NGC 16 | ~5540 | 20-dry | X | | 98 | X | Variable | (b) | <10 | <10 | <10 | Low |
| NGC 14 | ~5800 | 168.3-4.0 | | | 98 | X | Variable | (b) | <10 | 10-30 | <10 | Low to Moderate |
| NGC 15 | ~5800 | 26.0-0.1 | | | 98 | X | Variable | (b) | <10 | 10-30 | <10 | Low to Moderate |
| NGC 50 | ~5360 | 564.5-1.22 | X | | 98 | X | Variable | (b) | <10 | <10 | <10 | Low |
| NGC 51 | ~5400 | 2.3-1.0 | | | 98 | X | Constant | (b) | <10 | 10-30 | <10 | Moderate to High |

[1] Includes all springs located with 10-foot drawdown contour, and springs located outside of, but within approximately 2 miles of the 10-foot drawdown contour.

[2] Estimates of spring impacts are based on general hydrogeologic conditions, projected drawdown, and geochemical and isotopic signature.

(a) Spring is located southeast of the Betze-Post Pit in an area where drawdown contours have not been defined in the Boulder Valley Monitoring Plan (BVMP) (Barrick 1999a). Drawdown was estimated by extrapolating the BVMP contours to the southeast.

(b) Spring site is located on the east of the Tuscarora Mountain divide, in areas that may be experiencing drawdown from dewatering at the Gold Quarry Mine.

also flowed several thousand feet prior to infiltrating Boulder Valley.

The combined flows from these springs have ranged up to a peak of approximately 30,000 to 35,000 gpm in the first quarter of 1996. From April 1996 through 1998, water management activities were modified such that excess mine water no longer seeped through the fracture. These activities substantially reduced the amount of water that infiltrated the rhyolite and alluvial aquifer systems in the Boulder Valley area from 1997 through 1998. As a result, the flows in the springs diminished to approximately 5,000 gpm by the end of 1998.

Substantial decreases in spring flow reduced the surface area affected by the flows. As illustrated in Figure 3.2-28 (Barrick 1999a), the maximum extent of the spring flow area was approximately 4,500 acres (7 square miles) and occurred in January of 1996 (Barrick 1999a). At the end of 1998, the land areas directly affected by these flows had been reduced to approximately 12.5 acres (0.02 square mile) and were restricted to the immediate vicinity of the springs (Barrick 1999a).

Impacts to streamflows are identified by comparing recent monitoring data to data recorded in the late 1980s and early 1990s (Barrick 1999a; BLM 1991a). Noticeable changes to seasonal streamflow durations are evident for Rodeo Creek and Brush Creek in the vicinity of the Betze-Post Pit. Formerly perennial or frequently flowing intermittent reaches of these streams are now dry during much of the year. Since the 1988 and 1989 data reflect years of substantially lower precipitation than normal, it is likely that substantial flow reductions have taken place along these streams. These or similar impacts were predicted in the Betze Project Final EIS, and related mitigation measures were identified in Section 2.3.4 of that document (BLM 1991b).

The flow and vegetation in Brush Creek, a tributary to Rodeo Creek, have changed substantially since 1993, indicating that this drainage has been impacted by mine dewatering (Adrian Brown Consultants, Inc. 1999). Brush Creek has been dry since 1994 (Adrian Brown Consultants, Inc. 1999). Wetland species have been eliminated, and vegetation coverage has been reduced from 79 percent in 1993 to less than 24 percent in 1998 (Adrian Brown Consultants, Inc. 1999).

**Predicted Future Impacts (Post-1998).** The model predicts that the area within the 10-foot drawdown contour would expand after mining ceases and reach a maximum extent on the order of 100 years postmining. As stated previously, individual springs and perennial stream reaches are supported by discharge from either the regional ground water aquifer system or from more isolated or perched aquifers residing above the regional ground water system. Only those perennial sources that are hydraulically connected to the regional ground water system could potentially be impacted by mine-induced drawdown. Therefore, impacts to individual springs and perennial stream reaches that are supported by perched aquifers residing above the regional ground water system are not anticipated. Conversely, perennial springs that are hydraulically connected to the regional ground water system, and experience any drawdown could be impacted.

The actual impacts to an individual spring or stream reach would depend on the source of ground water that sustains perennial flow and the actual mine-induced drawdown that occurs at the site. The extensive spring and stream data collected to-date, including flow measurements, field water quality parameters, laboratory water quality isotopic determinations, and hydrogeologic conditions at each site are quite variable throughout the region. As a result, it is not possible to conclusively identify regions or specific springs or stream sites that would or would not be impacted by future mine-induced drawdown. However, there are several generalizations that can be made regarding the source of perennial waters and relative likelihood of impacts for different regions.

As listed in Table 3.2-22, there are 70 identified spring sites located within the predicted maximum extent of the 10-foot drawdown contour. Of these 70 spring sites, 26 were estimated to have a low likelihood of impacts from drawdown, and the remaining 44 were estimated to have a higher likelihood of impacts from drawdown. The relative potential for impacts was estimated based on the

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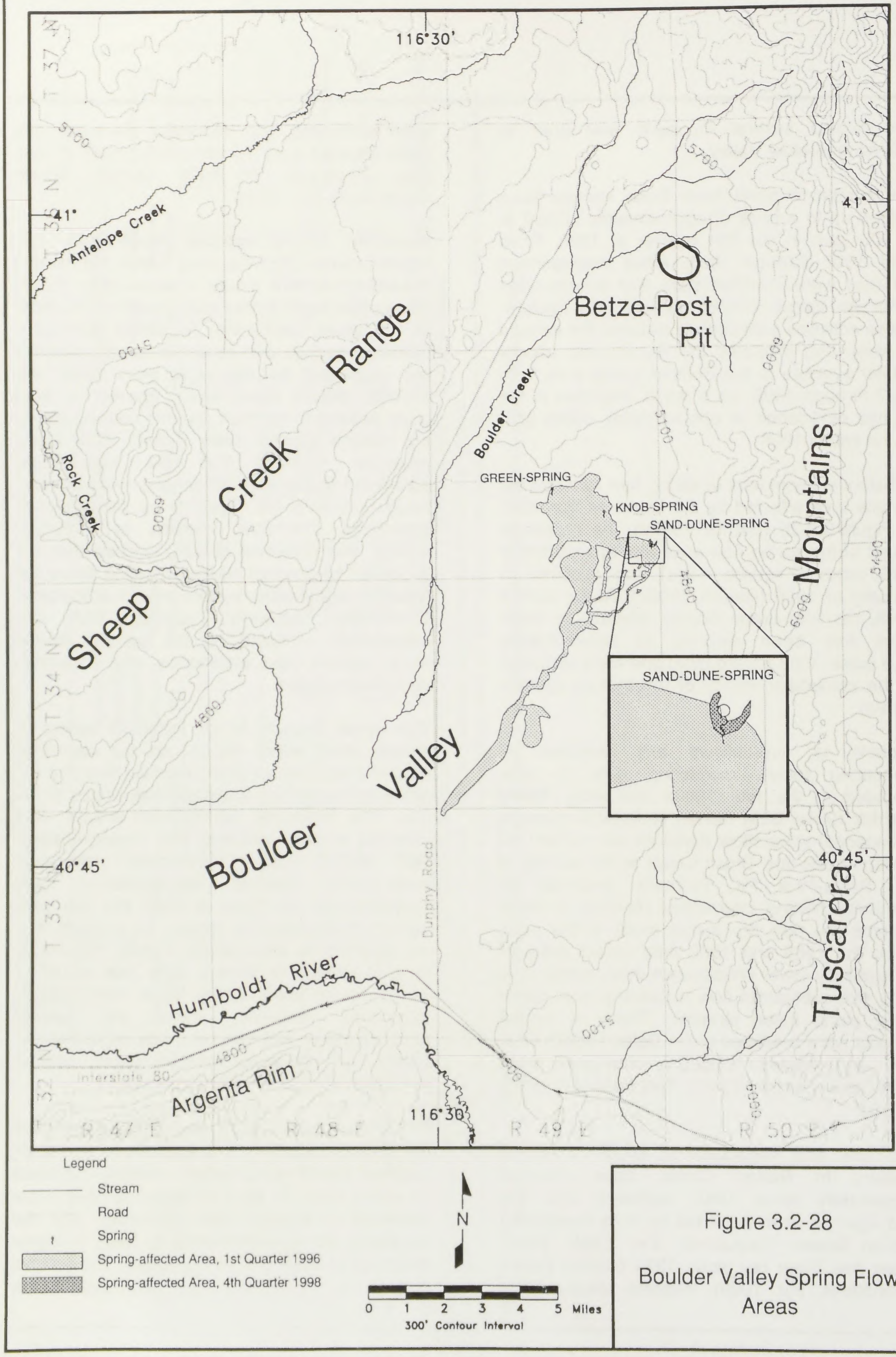

Figure 3.2-28

Boulder Valley Spring Flow Areas

general hydrogeologic setting, projected drawdown, and geochemical and isotopic signature from monitored springs. The areas where these 44 spring sites occur are shaded in Figure 3.2-29 to illustrate where perennial waters could potentially be affected (within the 10-foot drawdown area). Perennial springs and stream reaches located outside the 10-foot contour also could be affected by drawdowns of less that 10 feet. Identified spring sites located outside, but adjacent to, the 10-foot drawdown contour also are listed in Table 3.2-22 and include local perennial springs in the upper Antelope and Squaw Creek area, and Boulder, Bell, Brush, and Rodeo Creek areas. Potential impacts to perennial springs and streams are summarized by regions in the following paragraphs.

Upper Antelope Creek Area. This area includes several springs and seeps and the spring-fed perennial reaches of upper Antelope Creek and its tributaries Squaw Creek and the lower portion of North Antelope Creek. Current drawdown patterns and projected drawdown indicate that the cone of depression is expanding in a northwest direction toward the upper Antelope Creek and Squaw Creek areas. Model predictions indicate that the future drawdown would stop short of, but near, the upper Antelope Creek and lower Squaw Creek areas. The springs in this region generally have intermediate to high ionic concentrations and very low tritium concentrations. This signature suggests that these waters are older and probably derived from a more regional ground water source. Considering the uncertainty associated with long-term model predictions, there may be some risk that future drawdown could affect this area. If drawdown does extend to this area in the future, some springs and perennial stream reaches, particularly in upper Antelope Creek (below the confluence with Squaw Creek) and lower Squaw Creek, could potentially be impacted.

Rock Creek/Willow Creek Area. As summarized in Section 3.2.1.2, flow data indicate that baseflow in the segment of Rock Creek immediately north of the Sheep Creek Range is controlled predominately by flow from Willow Creek and Rock Creek tributaries located upstream from the Antelope Creek confluence. During low flow periods, flows in Rock Creek (north of the Sheep Creek Range) appear to be controlled by discharge from Hot Lake, located in the northern portion of the Rock Creek drainage near the confluence of Rock Creek and Willow Creek. In contrast, baseflow contributions from the Antelope Creek tributary watershed appear to be negligible. This is supported by the fact that approximately 12 miles of lower Antelope Creek are ephemeral (or generally dry during the low-flow season), and that baseflows have not been observed to increase significantly below the Antelope Creek confluence. For these reasons, it is reasonable to assume that even if drawdown did eventually impact upper Antelope Creek (as discussed previously), impacts to Rock Creek baseflows would likely be negligible (or not measurable). Therefore, based on the current model predictions, impacts to the perennial surface water resources in the Rock Creek/Willow Creek areas are not anticipated.

Western Slope of Tuscarora Mountains. Numerous springs and short, isolated perennial stream reaches occur on the western slope of the Tuscarora Mountains located southeast, east, and northeast of the Betze-Post Pit. These springs occur in the upper Rodeo Creek, Brush Creek, Bell Creek, and Boulder Creek watershed areas. As stated above, several springs and at least one stream reach (Brush Creek) have apparently been impacted by drawdown. The magnitude and area of drawdown is predicted to expand toward the end of mining and particularly in the postmining period. Springs in this region have variable characteristics and include a mixture of perennial water sources, including (1) springs with lower ionic concentrations and higher tritium content suggesting that they may be isolated or perched springs situated above the regional ground water system, and (2) springs with higher ionic concentrations and low tritium content suggesting they represent older ground water discharged from a deeper ground water system. Assuming that many of the higher elevation springs in this region are fed by perched ground water systems, springs and perennial streams at higher elevations (generally above 6,000 feet) are less likely to be affected as compared with lower elevation areas. However, perennial springs and streams located in the higher elevation areas (above 6,000 feet) with higher ionic and low tritium concentrations could be affected as the magnitude and area of drawdown expands in the future.

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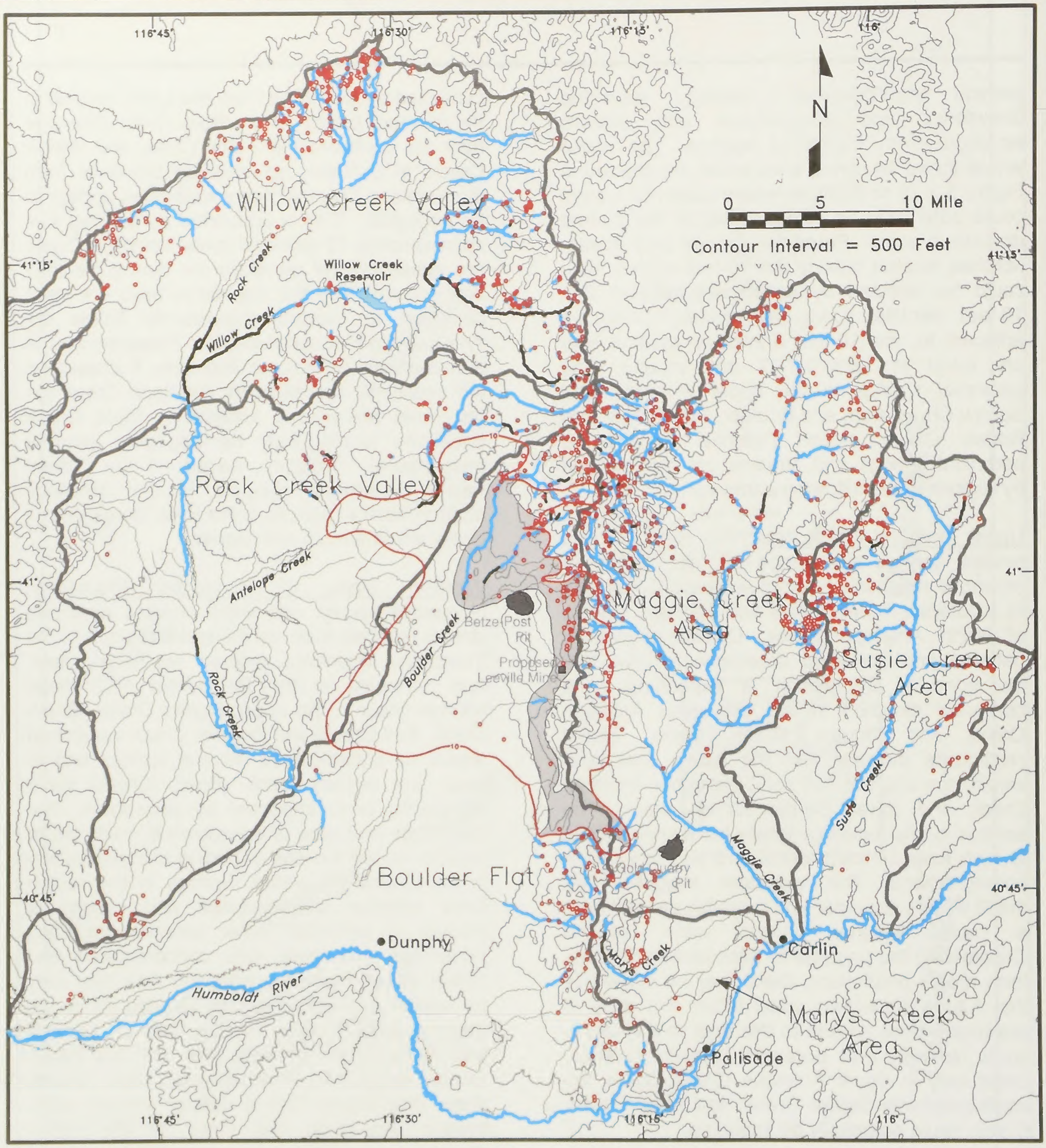

Note: [1] Does not include potential impacts to perennial waters located outside the maximum 10-foot drawdown contour.

Figure 3.2-29

Potentially Impacted Perennial Waters Within the 10-Foot Drawdown Area

Eastern Slope of Tuscarora Mountains. Numerous springs support perennial stream segments on the eastern slope of the Tuscarora Mountains that are part of the headwater tributaries of Maggie Creek including, from north to south, Beaver Creek, Little Beaver Creek, Coyote Creek, Spring Creek, Little Jack Creek, Indian Creek, Cottonwood Creek, Lynn Creek, and Simon Creek. According to the current model projections, in the postmining period, mine-induced drawdown is projected to extend into the Indian Creek, Cottonwood Creek, Lynn Creek, and Simon Creek areas. Springs within this area occur as discharges from low permeability Paleozoic bedrock that outcrops throughout this portion of the Tuscarora Mountains, and from thin alluvium over bedrock in the valleys. These springs generally are characterized by low total dissolved solids and high tritium concentrations (RTi 1994). The low ionic concentrations and high tritium content indicate that the ground water source for most springs and perennial waters in this area has a very short residence time that probably spans no more than a few years. Balleau (1992) collected and analyzed chemical and isotopic data from springs and streams, and conducted a geologic reconnaissance along Little Jack, Coyote and Beaver creeks, which drain the eastern side of the Tuscarora Range. Based on these data, Balleau developed a conceptual model for the streams along the eastern slope of the Tuscarora Mountains wherein baseflow in springs and perennial streams at higher elevation (approximately 6,000 feet) is supported by locally recharged water stored in colluvial material. The Desert Research Institute (DRI) evaluated the surface and ground water relationships in the Tuscarora Mountains (DRI 1998) and concluded that the existing data are consistent with this conceptual model of locally derived water. In summary, the chemical, isotopic, and hydrogeologic setting suggest that most springs in this region occur as isolated or perched springs that are not hydraulically connected to the deeper regional ground water system. Therefore, impacts to springs and perennial waters within this region from future mine-induced drawdown are generally not anticipated.

## Impacts to Ground Water Rights

To evaluate potential impacts to ground water rights, the drawdown predictions were compared to the point of diversion locations. Information on these rights and applications for rights is summarized in Appendix A, Table A-1; the point of diversion locations listed for the water right or application for water right are shown in Figure 3.2-8 (Nevada State Engineer's Office 1999, 2000). Water rights and applications listed as mining and milling were excluded from this analysis since these rights correspond to the network of mine dewatering wells centered around the Betze-Post and Gold Quarry pits. All other water rights and water right applications owned by Barrick or Newmont and their affiliates were included in the inventory. Since water rights are not necessary for most domestic wells, this inventory (based on information on file at the Nevada Division of Water Resources) does not include all domestic or stock watering wells that may exist within the regional study area. However, included in Table A-1 are five known water supply wells that are apparently used for domestic or stock watering and that do not have a water rights permit or application number. Other domestic water supply wells that are not included in this inventory likely exist in the vicinity of Carlin in the southeastern portion of the hydrologic study area.

As shown in Figure 3.2-30 and summarized in Table 3.2-23, the results of the modeling indicate that water levels in 64 underground water rights with current permit, certificated, or vested status could be lowered by at least 10 to over 100 feet during the mine life or in the postmining period as a result of Barrick's mine-induced drawdown. Considering the uncertainty of model predictions, the actual drawdown could be larger or smaller.

Specific impacts to individual wells would depend on the well completion, including pump setting, depth, yield and premining static and pumping water levels. Lowering the water levels in these water supply wells could potentially reduce yield, increase pumping cost. The pump setting in the well needs to be located a sufficient distance below the water table to allow for drawdown around the well during pumping without exposing the submersible pump. Therefore, mine-induced drawdown could render some wells unusable unless the pump setting were lowered or the well were deepened. For this reason, wells located within the areas affected by 10 feet of drawdown could potentially experience impacts.

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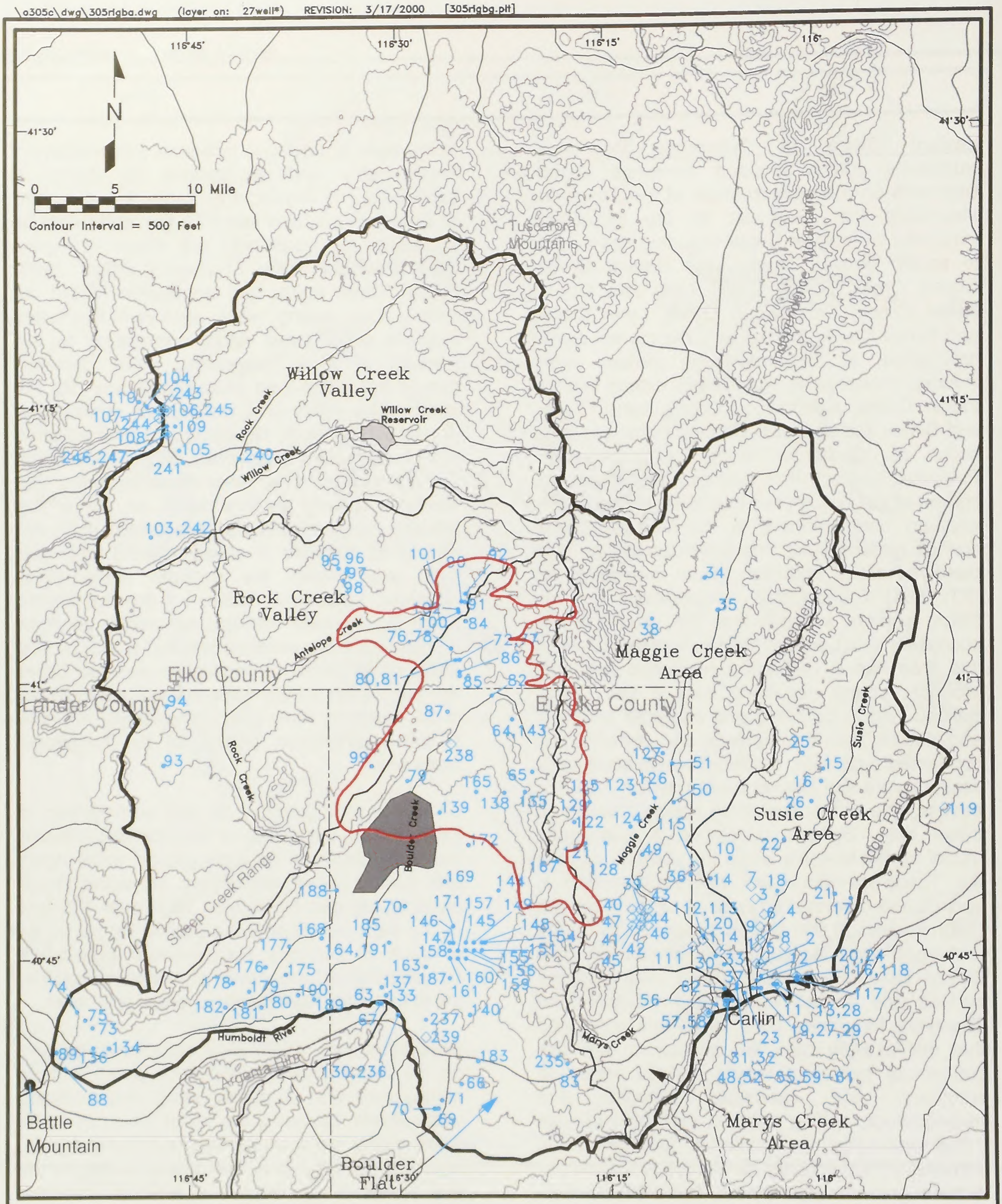

Legend

- Study Area
- Ground Water Basin Boundary
- County
- Maximum Extent of 10-foot Drawdown
- 70 Point of Diversion for Ground Water Right with Current Permit, Certificate, or Vested Status
- 47 Listed Point of Diversion for Applications for Ground Water Right (Application, Ready for Action, and Ready for Action Protested), and other known well locations
- ▇ This area contains 54 ground water rights and application for ground water rights (Numbers 68, 131, 132, 141, 142, 150, 152 153, 162, 166, 173, 174, 184 186, 192-215, and 218-233). The point of diversion locations are provided in Table A-1.

See Table A-1 for details

Figure 3.2-30

Potential Drawdown Impacts to Ground Water Rights, Application for Ground Water Rights, and Other Known Wells

## Table 3.2-23
## Ground Water Rights and Application for Ground Water Rights Located Within the Predicted Drawdown Area

| Map Well Location Number | Application Number | Status Permit/ Certificate[1] | Use[2] | Predicted Drawdown (feet) | | | |
|---|---|---|---|---|---|---|---|
| | | | | End 1998 | End of Mining | 100 Yrs Post-Mining | Recovery |
| 64 | 28197 | CER | MM | 10-100 | >100 | >100 | >30 |
| 65 | 30615 | CER | MM | ? | >100 | >100 | >30 |
| 72 | 53715 | PER | MM | >1100 | >100 | >100 | >30 |
| 76 | 57755 | PER | MM | 700-900 | >100 | >100 | >30 |
| 77 | 57756 | PER | MM | >1100 | >100 | >100 | >30 |
| 78 | 57757 | PER | MM | 700-900 | >100 | >100 | >30 |
| 79 | 57789 | PER | STK | 30-40[3] | >30 | 30-100 | >30 |
| 80 | 57882 | PER | MM | >1100 | >100 | >100 | 10-30 |
| 81 | 57883 | PER | MM | >1100 | >100 | >100 | 10-30 |
| 82 | 58254 | PER | MM | >1100 | >100 | >100 | >30 |
| 84 | 62579 | PER | MM | 10-100 | 30-100 | >100 | 10-30 |
| 85 | 57758E | PER | ENV | >1100 | >100 | >100 | 10-30 |
| 86 | 57759E | PER | ENV | >1100 | >100 | >100 | 10-30 |
| 87 | 57788 | PER | STK | >40[3] | ~10 | 30-100 | <10 |
| 90 | 42931 | PER | MM | <10 | <10 | 10-30 | 10-30 |
| 91 | 42932 | PER | MM | <10 | <10 | 10-30 | 10-30 |
| 92 | 42934 | PER | MM | <10 | <10 | 10-30 | <10 |
| 99 | 59063 | CER | STK | >40[3] | <10 | 10-30 | <10 |
| 100 | 61410 | PER | MM | <10 | 10-30 | >100 | 10-30 |
| 101 | 62577 | PER | MM | <10 | <10 | 10-30 | <10 |
| 102 | 62578 | PER | MM | <10 | 10-30 | >100 | 10-30 |
| 122 | 39874 | CER | STK | <10 | >100 | ~100 | 10-30 |
| 135 | 23881 | CER | STK | ? | >100 | >100 | >30 |
| 138 | 8659 | CER | STK | ? | >100 | >100 | 10-30 |
| 139 | 27956 | CER | STK | 30-40[3] | <10 | 10-30 | <10 |
| 143 | 28969 | CER | STK | 10-100 | >100 | >100 | >30 |
| 165 | 46042 | CER | STK | 30-40[3] | <10 | 10-30 | <10 |
| 166 | 46043 | CER | STK | 30-40[3] | <10 | 10-30 | <10 |
| 167 | 46044 | CER | STK | <10 | 30-100 | 30-100 | 10-30 |
| 192 | 52941 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 193 | 52942 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 194 | 52943 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 195 | 52944 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 196 | 52945 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 197 | 52946 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 198 | 52947 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 199 | 52948 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 200 | 52949 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 201 | 52950 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 203 | 54827 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 204 | 54828 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 205 | 54829 | PER | IRR | 30-40[3] | <10 | 10-30 | <10 |
| 238 | 64229 | RFP | STO | 30-40[3] | <10 | 10-30 | <10 |

See Appendix A-1 for Details on the Ground Water Rights, Application for Ground Water Rights, or Other Known Wells.

[1] Use:
CER - Certificate
PER - Permit
RFP - Ready for Action (protested)

[2] Use:
ENV - Environmental
IRR - Irrigation
MM - Mining and Milling
STK –Stock
STO - Storage

[3] Ground water mounding (not drawdown).

### Impacts to Surface Water Rights

A potential reduction in the baseflow of perennial springs and streams could affect surface water rights within the drawdown area (Figure 3.2-31) (Barrick 1998c; Nevada State Engineer's Office 1999). As shown in Table 3.2-24, there are 18 surface water rights that could potentially be impacted by mine dewatering induced drawdown. Twelve of these surface water rights are directly associated with Barrick's water management activities (as noted in footnotes 4 and 5 of Table 3.2-24). These water rights are dependent on Barrick's dewatering rights which terminate with completion of dewatering activities. Of the remaining six surface water rights, three are used for irrigation and three for stock watering.

The actual potential for impacts to individual water rights (not controlled by Barrick) would depend on the site-specific hydrologic conditions that control surface water discharge. For example, as discussed previously under springs and seeps, only those waters that are sustained by discharge from the regional ground water system are likely to be impacted by mine-induced drawdown. Some surface water rights divert only surface water runoff or local perched ground water that is not dependent on discharge from the regional ground water system. In these cases, impacts to surface water flows from mine-induced drawdown are not anticipated.

### Channel Erosion and Sedimentation Impacts

**Impacts to Date.** The discharge conveyance system has not and is not expected to substantially accelerate erosion and sedimentation in Boulder Valley. Best management practices have been employed during construction activities related to the conveyance system that avoid the use of natural channels in the discharge program. A reclamation plan revision is in place with the State of Nevada to account for reclamation of the conveyance system, and updates to the overall reclamation plan for the project are being submitted every 3 years as required by the State (Barrick 1996a, 1996b). Bonding in the plan revisions accounts for the conveyance system and includes a provision for $1 million for additional reclamation activities, the need for which is currently unforeseen.

The water management program has created agricultural land uses on thousands of additional acres in the Boulder Valley watershed. Vegetation density is estimated to be higher in these areas than in the native plant communities. The present system of cropland use and irrigation likely reduces the erosion and sediment yield than occurs naturally on undisturbed ground; however, this has not been quantified.

**Projected Future Impacts.** When dewatering and discharges cease, additional impacts may occur to local Boulder Valley watersheds in the form of impacts to soil resources. As mine dewatering ceases, it is assumed that approximately 10,000 acres of land would be taken out of agricultural production. At that time, accelerated erosion may occur on former croplands and affect land and water resources. If former croplands are not adequately reclaimed, increased erosion would contribute to sediments in Boulder Valley channels, which would most likely be transported downstream as suspended load and bed load. Additional sediment loading to local streams and the Humboldt River could affect biological resources (see Sections 3.3, 3.4, and 3.5) and other water uses.

### Water Quality Impacts

Water quality impacts are possible in areas affected by mine water management activities. These activities include or have included:

- The use of infiltration basins and injection wells to dispose of mine dewatering water into the alluvium and fractured rhyolite in upper Boulder Valley
- Seasonal irrigation of approximately 10,000 acres of alfalfa in Boulder Valley using mine dewatering water
- Temporary storage of mine dewatering water in TS Ranch Reservoir
- Various pipelines, canals, and ditches to transport and utilize excess dewatering water
- Water treatment facilities

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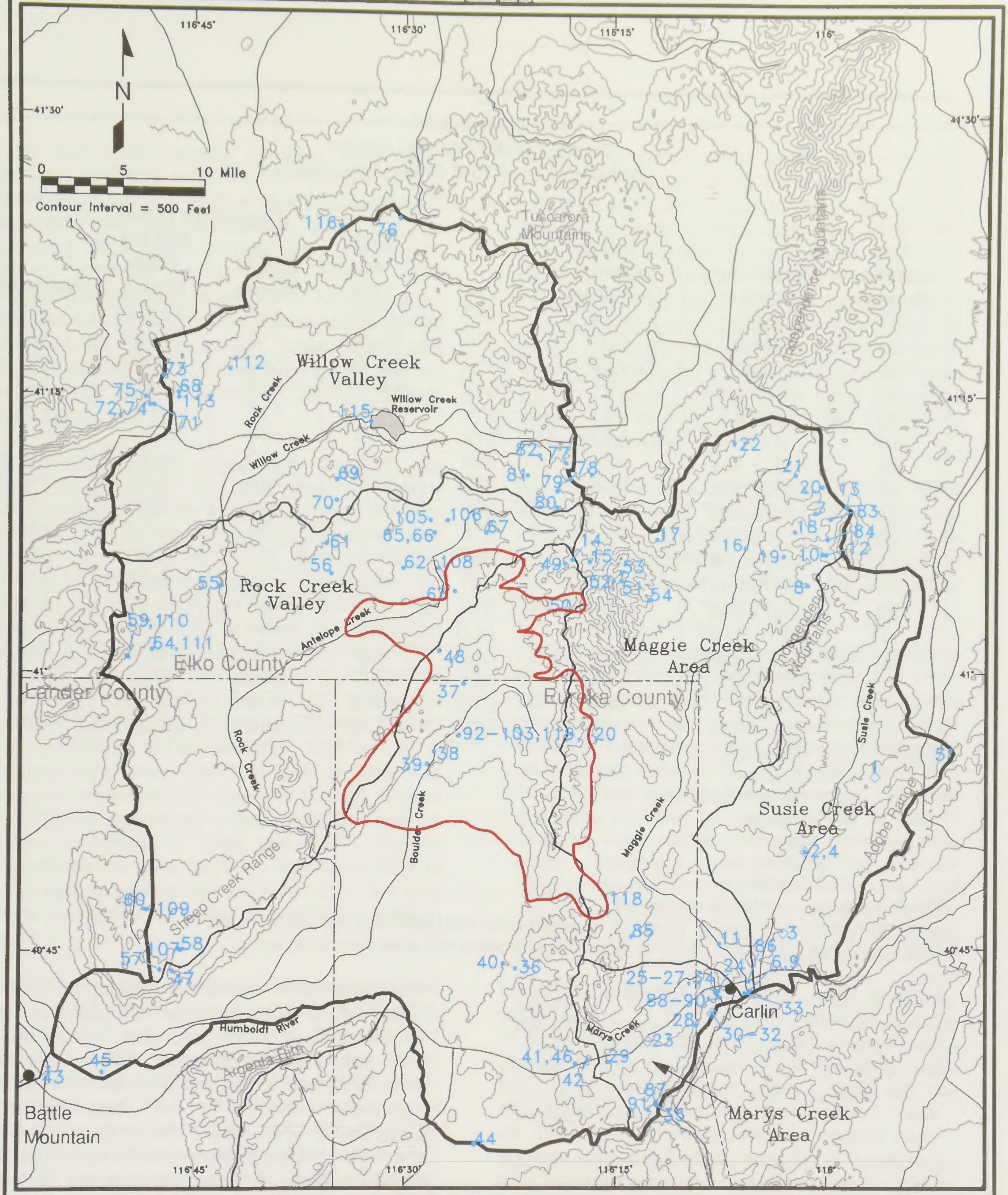

Legend

| | |
|---|---|
| ▬ | Study Area |
| — | Ground Water Basin Boundary |
| - · - · | County |
| ▬ | Maximum Extent of 10-foot Drawdown Contour |
| 46 • | Point of Diversion for Surface Water with Current Permit, Certificate, or Vested Status |
| 23 ◇ | Listed Point of Diversion for Applications for Surface Water Right (Application, Ready for Action, and Ready for Action Protested) |

See Table A-2 for details

Figure 3.2-31

Potential Drawdown Impacts to Surface Water Rights and Application for Surface Water Rights

### Table 3.2-24
### Surface Water Rights Located Within the Predicted Drawdown Area

| Map Location Number | Application Number | Status Permit/ Certificate[1] | Use[2] | Drawdown (Feet) | | | |
|---|---|---|---|---|---|---|---|
| | | | | End of 1998 | End of Mining | 100 Yrs Post-Mining | Recovery |
| 37 | 3035 | CER | IRR | >1100 | <10 | 30-100 | <10 |
| 38 | 3146 | CER | IRR | 30-40[3] | <10 | 30-100 | <10 |
| 39 | 3147 | CER | IRR | 30-40[3] | 10-30 | 30-100 | <10 |
| 48 | V06236 | VST | STK | 500-700 | <10 | 30-100 | 10-30 |
| 50 | V06242 | VST | STK | <10 | <10 | ~10 | <10 |
| 63 | V06237 | VST | STK | <10 | <10 | 30-100 | ~10 |
| 92 | 55272 S01[4] | PER | IRR | >40[3] | <10 | 10-30 | <10 |
| 93 | 55272 S02[4] | PER | STK | >40[3] | <10 | 10-30 | <10 |
| 94 | 55272 S03[4] | PER | IRR | >40[3] | <10 | 10-30 | <10 |
| 95 | 55272 S04[4] | PER | STK | >40[3] | <10 | 10-30 | <10 |
| 97 | 55272 S06[4] | PER | IRR | >40[3] | <10 | 10-30 | <10 |
| 98 | 55272 S07[4] | PER | IRR | >40[3] | <10 | 10-30 | <10 |
| 99 | 55272 S08[4] | PER | STK | >40[3] | <10 | 10-30 | <10 |
| 100 | 55272 S010[4] | PER | WLD | >40[3] | <10 | 10-30 | <10 |
| 101 | 55272 S011[4] | PER | WLD | >40[3] | <10 | 10-30 | <10 |
| 103 | 55272 S013[4] | PER | STK | >40[3] | <10 | 10-30 | <10 |
| 119 | 55272[5] | PER | STO | 30-40[3] | <10 | 10-30 | <10 |
| 120 | 55272 SO9[4] | PER | STK | 30-40[3] | <10 | 10-30 | <10 |

[1] Status: CER - Certificate
PER - Permit
VST - Vested Right
[2] Use: IRR - Irrigation
STK –Stock
STO - Storage
WLD- Wildlife
[3] Ground water mounding (not drawdown).
[4] Secondary storage right at the TS Ranch Reservoir associated with mine dewatering rights.
[5] Primary storage right at the TS Ranch Reservoir associated with mine dewatering rights.

**Impacts from Infiltration Activities**. Some of these activities have resulted in ground water mounding in the alluvium and volcanic rocks in the upper Boulder Valley and, to a lesser extent, in the Rock Creek ground water basins. The water management operations associated with these springs are described in Chapter 1.0. As described in Chapter 1.0, three new springs (Green, Knob, and Sand Dune) appeared when a fracture developed beneath the TS Ranch Reservoir. Figure 3.2-28 illustrates the surface expression of the spring area as of the first quarter of 1996 and the fourth quarter of 1998.

Impacts to Date. No detectable changes in ground water quality have been observed in monitoring wells located in areas of Boulder Valley where water management activities have caused ground water mounding. Water quality data from seven monitoring wells in this area were analyzed to determine if there were any noticeable changes in the concentration of constituents that have State drinking water standards. Although there are fluctuations in the concentrations of some constituents in some wells, these trends were not consistent from well to well. For example, the concentration of total dissolved solids has increased slightly over time in monitoring well NA-14, but other monitoring wells showed no major changes in total dissolved solids concentrations.

Flow and water quality samples have been collected at Green, Knob, and Sand Dune springs in Boulder Valley. Trends in flow and constituent concentrations are discussed briefly in the following paragraphs. Since flows from each spring originate over large areas, flow measurements and water quality samples were taken at a downgradient point where flows can be channelized. For this reason, water quality data may be influenced by spring flows contacting soil or by other surface condition prior to sample collection.

Green Spring water quality has changed over time, as reflected by total dissolved solids concentrations, which were at a maximum from 1993 to 1995 but have shown a decreasing trend through 1997 (Figure 3.2-32) (Barrick 1999a). Values of pH from the spring remained alkaline with a relatively high pH from 1993 to 1995 (maximum value of 9.0); however, monitoring has shown a slight decreasing trend through 1997. Alkalinity remained fairly constant from 1993 to 1997 other than a slight rise in 1994 (maximum value of 320 mg/L as $CaCO_3$ measured). Arsenic concentrations were elevated slightly above drinking water standards from 1993 to 1995, with a maximum measured value of 0.15 mg/L (Figure 3.2-32), but decreased to concentrations near or below 0.01 mg/L in 1996 and 1997. Sodium concentrations were relatively high from 1993 to 1995 (approximately 500 to 1,000 mg/L), but they have decreased an order of magnitude through 1997.

Knob Spring water quality also changed over time with a maximum TDS concentration of 920 mg/L in 1993 and a decreasing trend through 1997 (Figure 3.2-32). Values of pH from the spring have remained alkaline with their highest levels measured from 1993 to 1995 (maximum value of 9.0) and a slight decreasing trend through 1997. Alkalinity has remained fairly constant from 1993 to 1997, with concentrations typically between 250 and 350 mg/L as $CaCO_3$. Arsenic concentrations were elevated from 1993 to 1995 with a maximum measured value of 0.09 mg/L (Figure 3.2-32), but have since decreased through 1997. Sodium concentrations were relatively high from 1993 to 1994, but have decreased to less than 50 mg/L through 1997.

Sand Dune Spring water quality has displayed the least fluctuation during the period of record as indicated by a fairly constant to a very slightly decreasing trend in total dissolved solids over time (Figure 3.2-32). Values of pH also have remained fairly constant (most values between 7.5 and 8.0) as have alkalinity concentrations, values of which were approximately 240 mg/L as $CaCO_3$. Arsenic concentrations have decreased slightly over time for the period of record (Figure 3.2-32). Sodium concentrations have decreased slightly from 59 mg/L in August 1992 to 37 mg/L in November 1998.

Based on anecdotal observations of soils in the formerly saturated areas of Boulder Valley, evaporation of spring water has resulted in an increased accumulation of salts at the surface and within the shallow surface soils in Boulder Valley.

Projected Future Impacts. The basic chemistry and concentration of trace metals in ground water that is pumped from marine clastic and marine carbonate rocks to dewater the pit area is similar to that of the native ground water in the alluvium and volcanic rocks in Boulder Valley. Figure 3.2-13 is a Piper diagram that shows that the basic chemistry of these ground waters is similar. In addition, trace metals that have State drinking water standards are found in similar concentrations in both mine dewatering water and the native ground water in Boulder Valley. Changes to water quality, including increasing total dissolved solids, can occur locally where movement of the infiltrating water causes dissolution of minerals within the substrate, especially where previously unsaturated. However, water quality impacts to the ground water in Boulder Valley due to mine water management activities are expected to be minimal.

Additional soil salinity accumulations would likely develop on formerly saturated lands below TS Ranch Reservoir. These areas are expected to collect additional runoff as long as containment berms are in place. Through capillary rise, naturally occurring background salts would accumulate on and near the soil surface under conditions of wetting and drying or plant uptake. Therefore, there is a potential for this condition to limit postmining land uses and create saline and/or alkaline runoff conditions. Barrick has

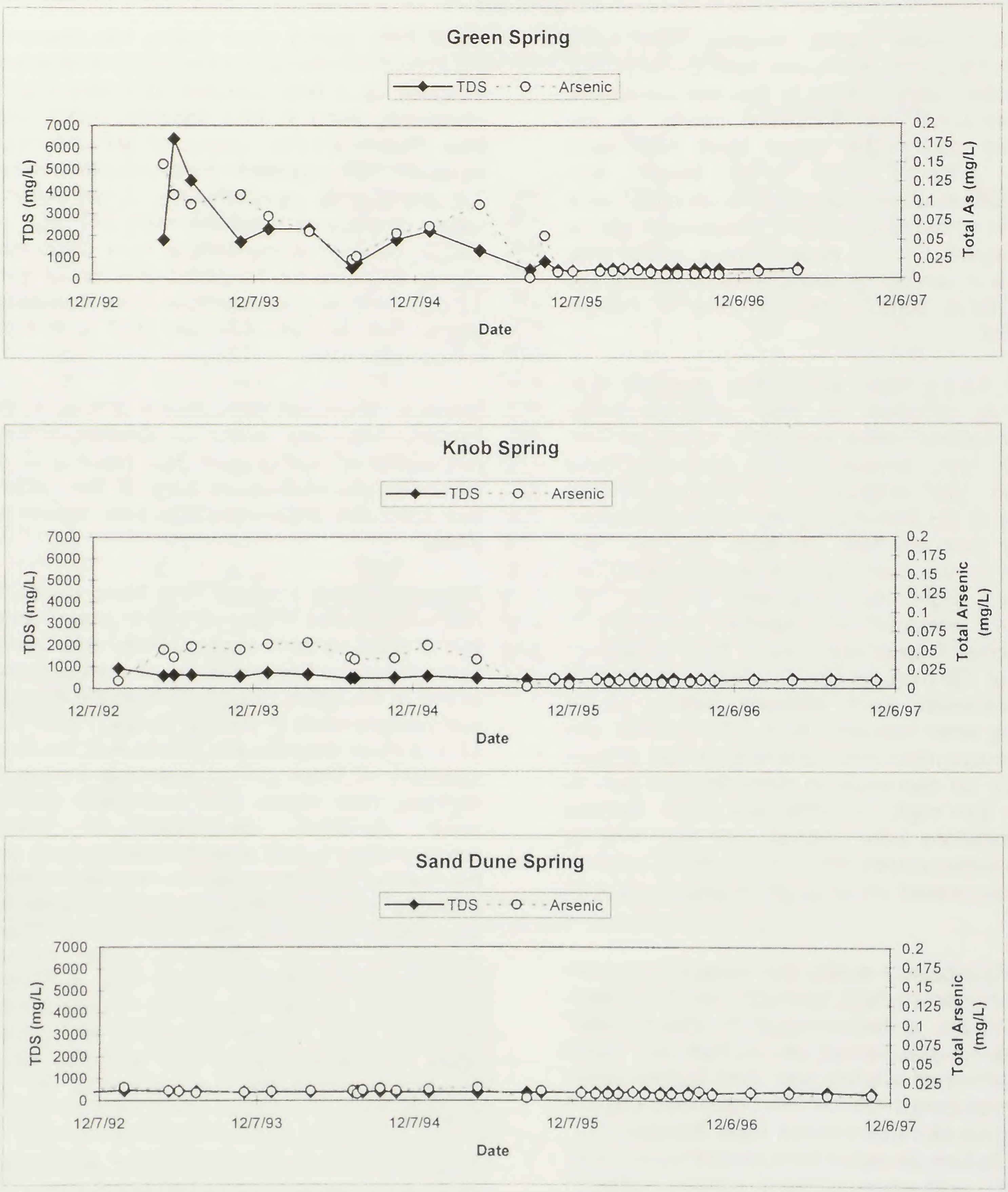

Figure 3.2-32

Total Dissolved Solids and Dissolved Arsenic Over Time for the New Springs in Boulder Valley reclamation and supplemental mitigation bonding in place to address such impacts if they occur.

**Impacts from Drawdown**. The primary issue related to the quality of surface water is degraded stream water quality resulting from drawdown.

Impacts to Date. Impacts to flows in springs, seeps, and perennial streams from pit dewatering and water management activities are addressed in Section 3.2.2.1. In summary, monitoring results suggest that drawdown from mine dewatering at the Goldstrike Mine has resulted in flow reductions and drying up of some perennial water sources. Depending on the origin of the ground water that discharges at the surface as a seep, spring, or stream, a reduction of flow could potentially be accompanied by a change in water quality. Where the source of the surface discharge is a single hydrostratigraphic unit (or aquifer) with relatively constant water quality, lowering the water level within the unit, and thereby reducing the surface discharge rate, should not result in a substantial change in water quality. Changes in flow could affect temperatures, and temperature-dependent water quality constituents could vary, however. Conversely, where the source of surface discharge is a mixture of waters from two different sources, such as a deeper, older more regional ground water aquifer, and a younger perched or more isolated ground water aquifer, a reduction in discharge from one of the sources could potentially skew the discharge water quality toward the less affected source. To-date, no substantial water quality trends have been observed within the drawdown area that could be attributed to flow reductions from drawdown.

Projected Future Impacts. Based on hydrologic modeling results, and seep, spring, and stream characteristics, there is some potential for additional flow reductions to perennial water sources in localized areas from future mine-induced drawdown (Section 3.2.2.1). Flow changes could potentially be accompanied by changes in water quality. The actual changes in water quality would depend on the magnitude of the flow change and the source of the surface discharge, as discussed above. Considering the complex hydrogeologic conditions, any change in water quality resulting from flow reduction is likely to be localized and is not possible to predict accurately.

Based on documented exceedences of Nevada Division of Environmental Protection stream water quality standards for water temperature and dissolved oxygen concentrations in LCT streams (Appendix B, Table B-8), both upper Rock Creek and Nelson Creek would be sensitive to any reduced flows resulting from drawdowns. However, Barrick's hydrologic model predictions and the impact assessment indicate that none of the LCT streams are likely to be impacted by drawdown.

**Pit Lake Water Quality**. Once dewatering operations cease, a pit lake would begin to develop in the Betze-Post Pit. Water quality predictions for the future Betze-Post Pit lake are based on a pit lake study and modeling by Radian International, LLC and Baker Consultants, Inc. (1997a, b). The primary processes controlling the pit lake water quality include ground water inflow composition, sulfide oxidation and acid generation in the pit walls, leaching of metals from the wall rock, chemical reactions in the lake, evapoconcentration, hydrodynamic mixing, and biological activity. Postmining conditions in existing mine pit lakes vary widely from high quality, pH-neutral conditions to metal-bearing, highly acidic conditions. Therefore, site-specific conditions are important to predict pit lake water quality. Water quality in the Betze-Post Pit lake was approximated using a series of quantitative models to simulate the chemical loading processes and ongoing chemical reactions that would occur in the lake water. The results of the pit lake study, including laboratory and field testing and hydrodynamic and geochemical modeling, are presented in a technical report prepared by Radian International, LLC and Baker Consultants, Inc. (1997a, b).

Pit Water Balance and Final Pit Lake Configuration. The variation in water level over time as the pit lake fills and the final pit lake elevation after filling would depend on the amount of water entering the pit through ground water inflow, surface runoff from the pit walls, direct precipitation onto the lake surface, ground water outflow, and the amount of water removed from the lake surface through evaporation. Barrick's hydrologic model was used to simulate the ground water inflow and outflow as the lake fills. Other gains and losses of water to and from the lake were calculated from documented meteorological sources or computed using the U.S. Army Corps of Engineers reservoir model CE-QUAL-W2. The estimated pit lake water balance over time is presented in Radian International, LLC and Baker Consultants, Inc. 1997a. Based on numerical modeling estimates, the pit lake would fill to within 95 percent (elevation 5,128 feet amsl) of its final recovery elevation in 233 years. The estimated near steady-state lake elevation at full recovery is estimated to be approximately 5,190 feet amsl, (Radian International, LLC and Baker Consultants, Inc., 1997a, b). During the final stages of pit filling, seasonal variations in precipitation and evaporation would dominate the pit lake water balance, adding uncertainty to the actual time required for complete filling. Once the lake is filled, the lake is predicted to have a net water loss through evaporation (evaporation losses minus precipitation inputs) at an average rate of approximately 2,800 acre-feet/year.

The estimated size and depth of the final Betze-Post Pit lake are illustrated in Figure 3.2-33 (Radian International, LLC and Baker Consultants, Inc. 1997a). At closure, the final pit as currently planned would actually consist of two distinct segments or lobes: the eastern segment, referred to as the Betze-Post area, would have an ultimate pit bottom elevation of 3,940 feet amsl; the western segment, referred to as the West Bazza-Screamer area, would have an ultimate pit bottom elevation of 3,990 feet amsl. The two pit bottoms would be separated by a rise in the pit floor reaching an elevation of 4,400 feet amsl. The final pit lake measured along the center line of the pit would be approximately 10,300 feet long, have a maximum depth of approximately 1,260 feet, and have a surface area of approximately 985 acres (1.5 square miles).

Ground Water and Surface Water Inflow. The water quality of the pit lake would depend, in part, on the composition of inflowing ground water. Ground water inflows to the pit can be classified into two primary types based on source: (1) warm, calcium-bicarbonate-enriched ground water from the Rodeo Creek and Popovich formations exposed on the west wall of the pit; and (2) lower temperature calcium-bicarbonate-type water containing higher silica concentrations and associated with the igneous intrusive rocks, Carlin Formation, and Vinini Formation exposed on the east and south walls of the pit.

For the pit lake model, it is assumed that 30 percent of incident precipitation falling on the unsubmerged pit surface would eventually contribute to the pit lake. The pit lake model simulations assumed that a percentage of this surface water would enter the lake as direct runoff, and the remainder would infiltrate the benches and eventually discharge to the pit lake as shallow ground water flow. Runoff was characterized by collecting flow measurements at selected locations in the pit and collecting samples for laboratory analysis of major ions and metal concentrations.

Pit Wall Rock. Pit wall rock would contribute solute to the pit lake. Therefore, the type of rock comprising the pit walls and its potential for generating acid and mobilizing metals and other constituents is an important part of the water quality predictions. The wall rock materials exposed in the ultimate pit surface were subdivided into nine major geochemical rock types based on geologic units, mineralization, and alteration types. Representative samples of the nine geochemical rock types were collected and tested to determine whole rock geochemistry (acid-base accounting, kinetic cell tests, and other column tests). The acid-base accounting tests and kinetic tests indicated that some of the unoxidized rock materials would be potentially acid generating (Radian International, LLC and Baker Consultants, Inc. 1997a, b).

The primary source of acid and metals to the lake is assumed to be wall rock that would oxidize in the time interval between excavation and submergence by the pit lake. In situ pore oxygen concentrations measured in wall rock exposed within the pit indicated that the pyrite oxidation had penetrated several meters into the pit walls. Calculations using the field-derived data indicate that pyrite oxidation could extend between 9 and 17 meters into the pit wall after approximately 225 years of exposure to weathering (Radian International, LLC and Baker Consultants, Inc. 1997a, b).

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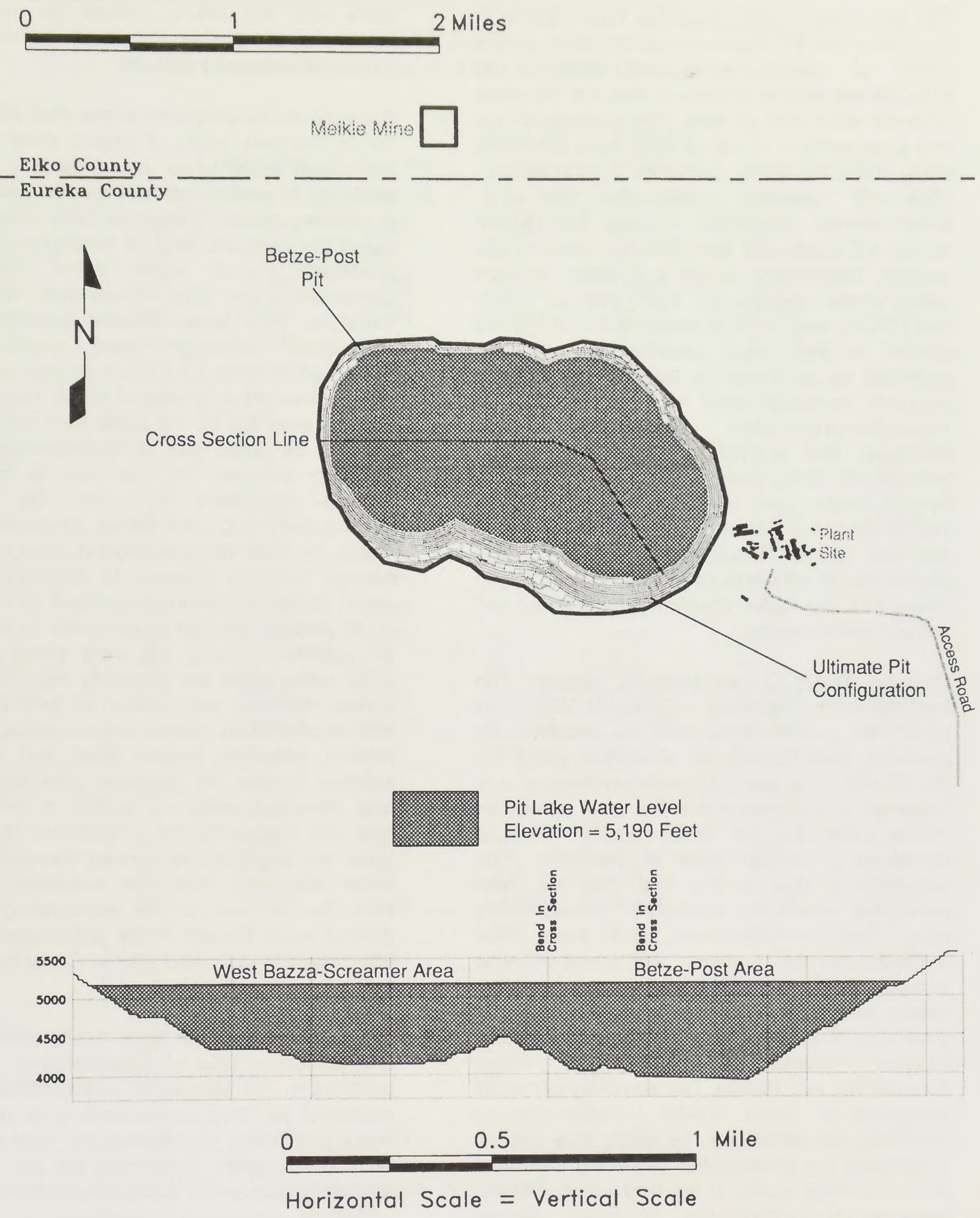

Note: Final pit configuration was based on information provided in Radian International, LLC and Baker Consultants, Inc., 1997b

Figure 3.2-33

Estimated Final Betze-Post Pit Lake

Pit Lake Water Quality Modeling. Water quality in the Betze-Post Pit lake was approximated using a series of quantitative models designed to simulate the natural processes that are expected to occur within the pit lake. The hydrodynamics and geochemistry of the pit lake were simulated using the U.S. Army Corps of Engineers CE-QUAL-W2 reservoir model and the U.S. Environmental Protection Agency MINTEQA2 model. CE-QUAL-W2 was used to represent the volume, bathymetry, stage and water balance relationships associated with the pit lake. MINTEQA2 was used to simulate the combined effects of the major geochemical reactions expected to occur during lake filling, including aqueous speciation, acid neutralization, mineral dissolution-precipitation, oxidation-reduction reactions, and sorption of trace metals onto precipitated amorphous ferric hydroxide. Lake hydrodynamics were simulated using CE-QUAL-W2 to account for thermal inputs and outputs to the lake, gas exchange from the lake surface, distribution of temperature and dissolved oxygen throughout the water column, algal growth, and nutrient mass loading.

Pit Lake Water Quality Modeling Results. The hydrodynamic modeling (CE-QUAL-W2) was performed in conjunction with the geochemistry modeling (MINTEQA2) for simulation years 10, 26, 50,100, 175, and 233 years postmining. It is important to understand that the input parameter values used for the water quality modeling contained a certain level of variability. The variability is due to the fact that the input parameter values are estimated from laboratory tests, field measurements, and even other modeling results. Because this variability was included in the modeling process, the modeling results generated a range of values for each parameter that represent a probability distribution (Radian International, LLC and Baker consultants, Inc. 1997a). The summary of results presented in Table 3.2-25 includes median predicted concentrations for each time period. There also are uncertainties regarding the future predicted water quality in the Betze-Post Pit lake. Because of uncertainties of future climatic conditions, ground water flow rates, and ground water compositions, the confidence in predictions of pit lake water quality tend to decrease with increasing time after the end of mining. Therefore, predictions made several decades or more into the future should be viewed as indicators of relative trends in concentrations rather than absolute values.

Because of the geometry of the final pit surface, during the early years of ground water recovery two separate pit lakes would develop and are predicted to persist for the initial 28 years of the postmining period. These two initial lakes, herein called the east and west pit lakes, have different predicted ground water inflow rates and compositions and different wall rock chemistries; therefore, they have different predicted water chemistries. Although water quality results presented in Table 3.2-25 indicate that at year 10, the median pH is predicted to be near neutral, there is potential for the initial east and west pit lakes to be acidic (pH of approximately 4) and gradually increase to near neutral to slightly alkaline conditions by year 26 (Radian International, LLC and Baker Consultants, Inc. 1997a, b). Until inflowing ground water could add enough buffering capacity to neutralize the pit water, sulfide oxidation of exposed pit wall rocks could produce enough acidic water to cause low pH conditions during the early years of filling. Initial metal loads are generally high during this period. However, precipitation of ferric hydroxide acts to continually remove trace metals, such as arsenic, cadmium, copper, lead, and zinc from solution. In year 26, predicted concentrations of total dissolved solids and sulfate in the west pit lake and concentrations of antimony in both pit lakes are predicted to exceed Nevada drinking water standards. However, substantial outflow from the pit lake to the surrounding regional ground water system is not anticipated (Radian International, LLC and Baker Consultants, Inc. 1997a).

The east and west pit lakes would coalesce into one combined lake at approximately 28 years postmining. The lake water quality results for two stages of pit filling corresponding to 10 and 26 years postmining for the east and west lakes and 50 and 233 years postmining for the combined lake are presented in Table 3.2-25. The predicted variations or trends in concentration over time for total dissolved solids, pH, sulfate, and antimony are shown in Figure 3.2-34 (Radian International, LLC and Baker Consultants, Inc. 1997a). The carbonate chemistry of the inflowing ground water is predicted to maintain the median pH of the lake

## Table 3.2-25
## Median Predicted Betze-Post Pit Lake Chemical Concentrations

| Constituent | Units | West Pit | East Pit | West Pit Lake | East Pit Lake | Combined Pit Lake | |
|---|---|---|---|---|---|---|---|
| | | Year 10 | Year 10 | Year 26 | Year 26 | Year 50 | Year 233 |
| Aluminum | mg/L | <0.021 | <0.021 | <0.021 | <0.021 | <0.021 | <0.021 |
| Ammonia as N | mg/L | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 | <0.1 |
| Antimony | mg/L | 0.038 | 0.055 | 0.032 | 0.066 | 0.041 | 0.032 |
| Arsenic | mg/L | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Barium | mg/L | 0.004 | 0.007 | 0.005 | 0.006 | 0.007 | 0.009 |
| Boron | mg/L | 0.685 | 0.083 | 0.584 | 0.106 | 0.453 | 0.654 |
| Cadmium | mg/L | <0.0024 | <0.0024 | <0.0024 | <0.0024 | <0.0024 | <0.0024 |
| Calcium | mg/L | 141 | 73.1 | 121 | 83.8 | 61.6 | 68.1 |
| Carbonate | mg/L | 51.9 | 64.2 | 50.7 | 62.2 | 64.6 | 48.9 |
| Chloride | mg/L | 20.3 | 18.9 | 17.0 | 22.5 | 18.8 | 23.4 |
| Chromium | mg/L | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 | <0.005 |
| Copper | mg/L | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 |
| Fluoride | mg/L | 1.62 | 0.950 | 1.65 | 1.14 | 1.45 | 1.72 |
| Iron | mg/L | <0.024 | <0.024 | <0.024 | <0.024 | <0.024 | <0.024 |
| Lead | mg/L | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| Magnesium | mg/L | 50.1 | 44.3 | 42.0 | 53.3 | 44.0 | 36.8 |
| Manganese | mg/L | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |
| Mercury | mg/L | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 | <0.0002 |
| Nickel | mg/L | <0.017 | <0.017 | <0.017 | <0.017 | <0.017 | <0.017 |
| Nitrate as N | mg/L | 1.93 | <0.05 | 1.84 | 0.321 | 0.654 | 0.274 |
| pH | -- | 8.06 | 8.16 | 8.08 | 8.14 | 8.20 | 8.08 |
| Phosphate | mg/L | <0.01 | 0.044 | <0.01 | <0.01 | <0.01 | <0.01 |
| Potassium | mg/L | 19.8 | 8.48 | 16.5 | 10.2 | 16.7 | 22.2 |
| Selenium | mg/L | 0.006 | 0.004 | 0.005 | 0.004 | 0.004 | 0.003 |
| Silica | mg/L | 19.2 | 29.1 | 16.0 | 34.8 | 29.9 | 34.7 |
| Silver | mg/L | 0.022 | 0.021 | 0.028 | 0.018 | 0.022 | 0.023 |
| Sodium | mg/L | 64.0 | 27.1 | 53.7 | 32.7 | 55.8 | 75.3 |
| Strontium | mg/L | 0.114 | 0.154 | 0.095 | 0.185 | 0.107 | 0.073 |
| Sulfate | mg/L | 671 | 329 | 562 | 396 | 356 | 283 |
| Total Dissolved Solids | mg/L | 1042 | 594 | 883 | 697 | 657 | 603 |
| Thallium | mg/L | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Zinc | mg/L | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 | <0.002 |

Source: Radian International, LLC and Baker Consultants, Inc. 1997a.

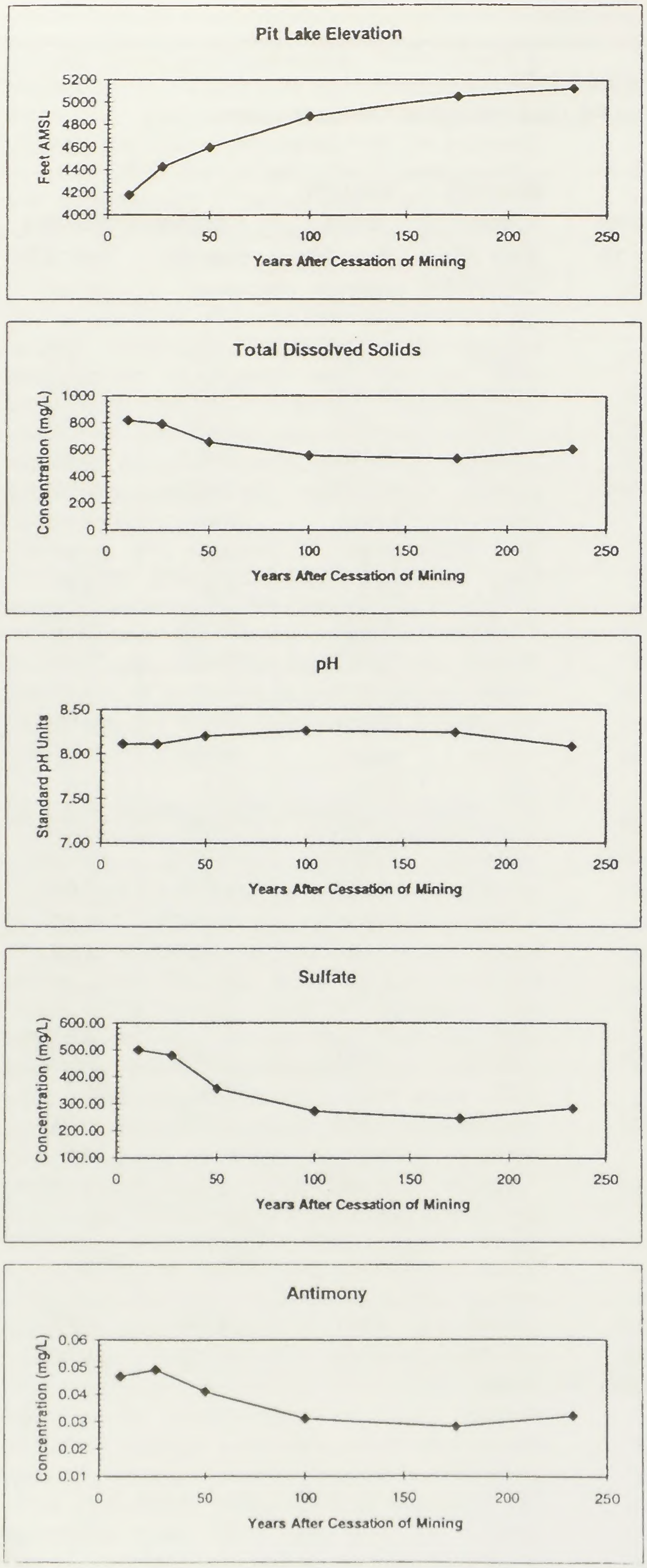

Figure 3.2-34

Betze-Post Pit Lake Trends in Median Predicted Chemical Concentrations at between 8.1 to 8.3 between years 28 and 233. Sulfate and total dissolved solids concentrations decrease for approximately the first 100 to 150 years of pit filling, but then start increasing slightly with time.

Chemical constituents of concern from a water quality standpoint are predicted to be antimony, total dissolved solids, and sulfate. Antimony concentrations are predicted to range from approximately 0.04 to 0.06 mg/L, which exceeds the primary drinking water standard of 0.006 mg/L. It should be noted that the geochemical model did not account for precipitation of antimony, thus actual antimony concentrations are likely to be lower than predicted. Total dissolved solids and sulfate concentrations gradually increase over time as a result of evapoconcentration of the lake waters, reaching a median predicted value of 740 mg/L and 375 mg/L, respectively, by 233 years postmining.

The lake is predicted to be well oxygenated throughout the entire filling simulation period, except seasonally when algae demand may reduce dissolved oxygen levels in some near surface water. The combined lake is expected to turn over in the autumn and is not expected to become anoxic. Because of the influx of warm ground water, the lake also is not expected to freeze under normal winter conditions.

Although modeling was performed out to 233 years (95 percent of the predicted steady state pit lake elevation), it is not anticipated that the pit water chemistry would be at chemical equilibrium at this time. Evaporation from the lake surface would continue to concentrate levels of total dissolved solids, sulfate, and other major cations and anions in the lake water for the foreseeable future. Precipitation of ferric hydroxide would continue in the future and would continue to remove selected trace metals.

Pit Lake Water Quality Impacts. Based on the hydrologic model (McDonald Morrissey Associates, Inc. 1998), the pit lake is predicted to behave as a long-term hydraulic sink. Therefore, substantial outflow from the pit lake to the surrounding ground water system is not expected. Since the pit lake is not expected to discharge to either surface or ground water, the pit lake is not expected to degrade surrounding waters of the state.

The pit lake is not intended to be a drinking water source for humans or livestock or to be used for recreational swimming. Therefore, standards to protect the lake as a drinking water source, livestock water supply, or for recreational swimming are not applicable. Aquatic standards also are not applicable because there is no intention to use the lake as a fisheries resource. However, fish could be introduced in the pit lake, and the lake would likely be used by waterfowl and terrestrial wildlife. A summary of potential impacts of the pit lake on waterfowl and wildlife is presented in Section 3.4.2.

#### 3.2.2.2 Impacts to the Humboldt River

Impacts to River Flows from Mine Discharge

**Background**. A Humboldt River regional study area was defined to assess potential impacts from mine discharges. This study area extends along the river from Carlin, Nevada to the Humboldt Sink, as shown in Figure 1-6. This analysis examines the potential impacts to the Humboldt River from recent and potential future mine discharges from the Goldstrike dewatering operations. The following sections describe the analyses and potential impacts related to flow regimes and water quality in the Humboldt River.

The location on the Humboldt River that has received mine discharges is at the Goldstrike Mine discharge outfall, located near the western Eureka County line (Figure 1-6). Given the availability of data and the location of discharge into the Humboldt River, the impact analysis to the Comus gage is more quantitative, and the impact assessment of the river below Comus is more qualitative in nature. As described in Section 3.2.1.3, substantial flow losses occur in the river downstream of Battle Mountain and Comus.

Barrick has an NPDES permit to discharge dewatering water to the Humboldt River at its discharge outfall. To-date, Barrick has discharged water at this location from September 1997 through February 1999 (see Figure 3.2-35). Barrick currently intends to dispose of excess dewatering water (i.e., water not required for

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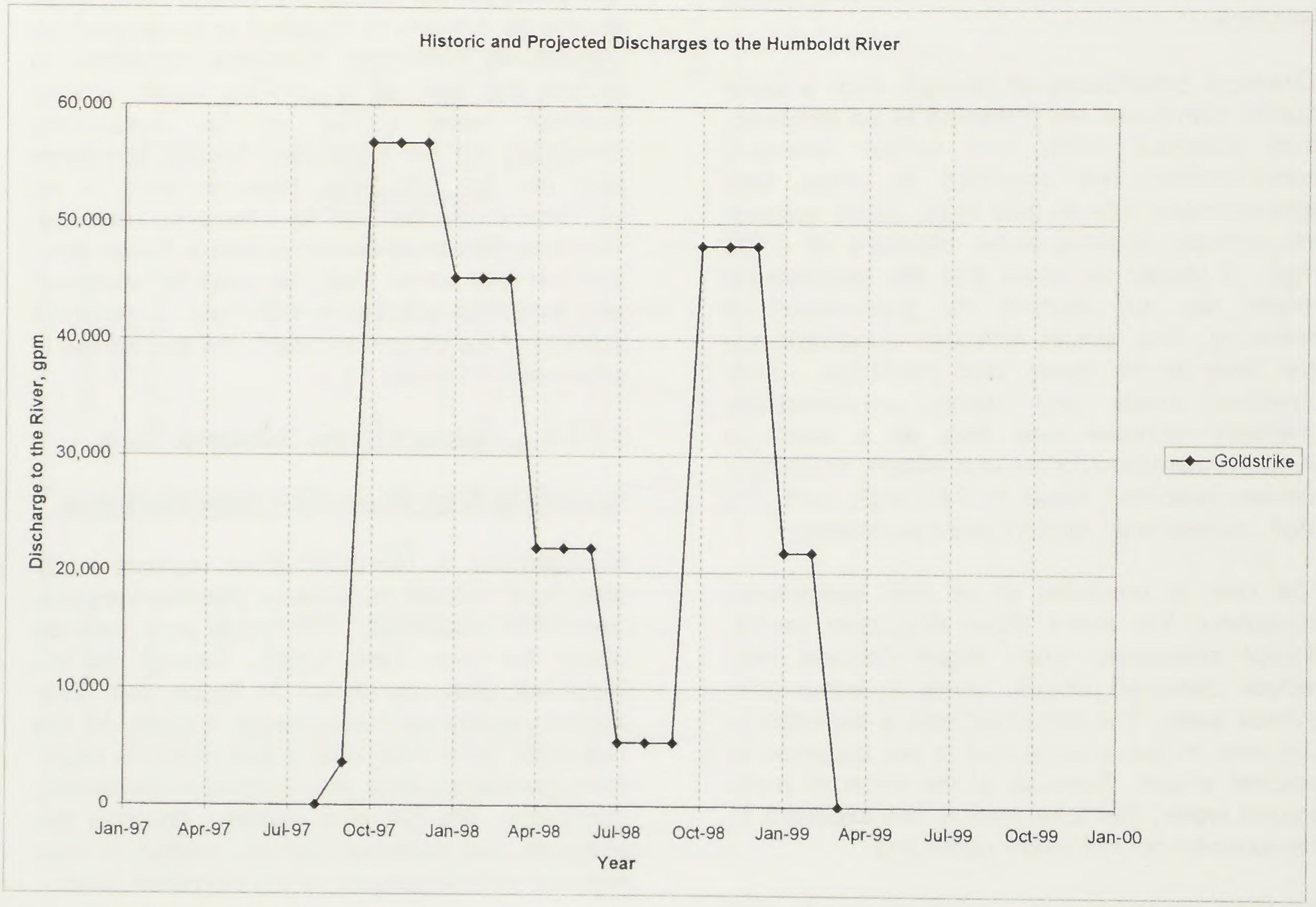


Figure 3.2-35

Goldstrike Mine Discharges to the Humboldt River operating the Goldstrike Mine or for irrigation), in cooperation with Newmont, through infiltration into the rhyolite formation in Boulder Valley. **If additional water disposal were necessary**, Barrick could discharge the remainder, up to 70,000 gpm, to the Humboldt River. The amount of water pumped for dewatering is not equal to the amount of water discharged to the river. A substantial amount of the water is consumed in mining operations, irrigation, infiltration, injection, and other uses. The magnitude of these uses varies seasonally. The remaining flows would be treated, as necessary, to meet Nevada discharge standards prior to release to the river.

**Impacts to Date to Humboldt River Flows.** Impacts to-date from mining discharges to the Humboldt River were examined by reviewing precipitation and stream gage data. The data review compared flow data for the years 1946-1990 (pre-pumping and pre-discharge) to the flows in the periods when mine dewatering occurred (September 1997 through February 1999) (river flow data for 1999 were not yet available at the time of this document). Available precipitation data, including both snow and total annual precipitation, also were reviewed during this comparison in an effort to put the streamflow data in the context of general climatic conditions in the Humboldt River basin. This review used a simple comparison and rating system that examined several precipitation stations with meaningful data histories in the upper part of the river basin (above Palisade) and several in the lower part of the river basin (below Palisade). No other major influences on streamflows (as described in Section 3.2.1.3) were included in this semi-quantitative review. The results of the data review are shown in Appendix C, Tables C-9 and C-10.

In part, the data examination demonstrates the variation in precipitation and flow regimes over time and from location to location within the basin. In Table C-9 for example, point precipitation data for 1992 at Battle Mountain were approximately 37 percent above normal at that particular location. However, on an area-wide basis using several additional stations, both the upper and lower subbasins had below normal rainfall. In 1991 and 1994, the upper and lower Humboldt River sub-basins differed in precipitation but did not differ substantially in relative streamflows. As northern Nevada generally emerged from several years of drought in the late 1980s and early 1990s, a general increase in streamflows occurred throughout the Humboldt River basin (Table C-10). The years 1995 through 1998 were generally characterized by high precipitation accumulation and correspondingly higher streamflows. Substantially greater increases in streamflows can be seen in 1995 through 1998 data for Battle Mountain and other downstream gages in comparison to the upstream Carlin and Elko data. It is this variation in conditions that is important to flow characterization and analysis of potential impacts.

Goldstrike Mine discharges would enter the Humboldt River below Dunphy and upstream of the Battle Mountain gage. Mine discharges probably had some effect on the greater annual increases in streamflow at that location and farther downstream during the 1997-1998 period (where higher annual flows are evident in the record). However, incremental effects of mine discharges on the river flows are not clearly expressed in the streamflow data alone. In some months, decreases in flow from upstream to downstream are evident. Appendix C, Table C-11 presents the flow variations during the recent higher flow years of 1995 through 1998.

The 1997 data indicate that streamflow increased substantially in the winter and spring prior to Barrick's historical discharges (starting in September 1997). For example, the mean monthly flow for January 1997 at Palisade (above the Goldstrike discharge) is 613 cfs. The 1946-1990 January average is 176 cfs. In contrast to the Palisade data, the mean monthly flow for January 1997 at Battle Mountain is 1,123 cfs, and the 1946-1990 January average is 178 cfs. Similar conditions can be observed in other monthly data for the higher flow years between Palisade and Battle Mountain. It also should be noted that January 1997 flows at Battle Mountain are approximately 80 percent in excess of the maximum 1946-1990 flow for that month, and Goldstrike Mine discharges to the river had not begun. The dramatic flow increases at Battle Mountain probably were caused by regional weather phenomena (such as rain on snow) similar to what occurred in other Nevada river basins at the time. For other months, combined river and mine discharges recorded at the Battle

Mountain gage are all within the historical monthly range of flows (Appendix C, Table C-8).

Between September 1997 and September 1998, comparison between the Dunphy and Battle Mountain data may suggest that a larger portion of the flow increases could be composed of mine discharges (Appendix C, Table C-11). The differences in flows between Dunphy and Battle Mountain during these months are more similar to the magnitudes of the mine discharges. An examination of winter temperature and snowfall data from several weather stations indicates that in earlier high-flow years (1995 through early 1997) the flow increases between the Dunphy and Battle Mountain gages were probably caused by high snowfall in December and January accompanied by warmer than average temperatures. Such conditions increase the potential for rain-on-snow events and snowmelt flooding, and the larger snow accumulations encourage greater runoff in the spring and early summer. In contrast, during the winter of 1997-1998, there were substantial flow increases between the two streamflow gages, but little snow and less monthly precipitation overall than in the previous 2 years. It is likely that the flow conditions between Dunphy and Battle Mountain were affected by Barrick discharges from October 1997 through February 1998. Much higher precipitation than normal occurred later in March through May 1998, and this masks the causes of flow increases between the gages during these and later months. Mine discharges were smaller during the growing season, and irrigation practices and other factors affect the data later in the spring and summer of 1998. In any case, the flow increases between the stations during the discharge period are similar to those that occurred naturally in the years prior to discharge (Appendix C, Table C-11).

Similarly, streamflow data at the Comus gage are influenced by the Goldstrike Mine discharges. Between Battle Mountain and Comus, flow changes in the recent high-flow years generally reflect conditions similar to those upstream. More use (loss) of the mine discharges can be seen in this reach. In addition, there are considerably more months where there are substantial flow decreases between stations, even with the contributions from mine discharges. For all months, the combined river and mine discharges as recorded at the Comus gage are within the historical monthly range of flows (Appendix C, Table C-8).

It should be noted, per the calculations and footnote on Table C-11 of Appendix C, that it is quite possible for part or all of the mine discharges to be withdrawn from the river and consumed by other users of Humboldt River water. This may have occurred as an impact-to-date as reflected in the table entries where substantial flow losses are shown from upstream to downstream gages. In such cases, beneficial impacts to water users may have resulted from the mine discharges.

At times, mine discharges to-date have contributed to flow increases in the Humboldt River. However, this data review indicates that various conditions and water uses contribute to Humboldt River streamflow data, including differences in the size of the drainages being gaged, precipitation accumulation and snowmelt in different parts of the basin, alluvial aquifer gains and losses, agricultural diversions and returns, evapotranspiration, as well as mine discharges. As a result, it is not possible to quantitatively distinguish the incremental increase in flow attributable to the combined mine discharges by a simple comparison of streamflow records. However, qualitative conclusions may be made for some periods using additional data sources (National Climatic Data Center 1999).

In summary, the range of monthly data recorded prior (1946 to 1990) to the pumping and discharge period was compared to the mine discharge period (1997 to 1998) to see if any unusual or anomalous patterns were recorded during the discharge period (Appendix C, Table C-8). The comparison indicates that although some effects on flows may be observed, for all months except January 1997 at Battle Mountain (as explained previously), the range of flows recorded during the Goldstrike discharge period to-date (1997 and 1998) is within the range of flows recorded historically (1946 to 1990). Regional weather conditions, not Barrick water management operations, were probably the cause of the anomalous high flows at Battle Mountain in January 1997. Also, where river flow data are available during the mine discharges (September 1997 to 1998), the conditions in the river were generally similar to other recent high-flow periods (1995 to August 1997). This comparison suggests that mine discharges through 1998 have not resulted in anomalous flow conditions in the river.

**Projected Future Impacts to Humboldt River Flows.** Estimates of mine discharges to the Humboldt River for this flow analysis were based on actual historic discharges from 1997 through 1998 and estimated potential future mine discharges for the post-1998 period. RTi (1998) provided an estimate of potential future discharges from each of the mines based on information provided by Barrick. In 1999, Barrick provided revised estimates of future mine discharges to the Humboldt River for the Goldstrike Mine (Barrick 1999b). Compared to the earlier estimates (RTi 1998), the revised estimates indicate that the Barrick would no longer discharge to the Humboldt River after the first quarter 1999 (earlier estimates assumed Barrick would discharge from 1999 through 2011). The reduction in discharge and change in discharge periods for the Goldstrike Mine reflect that under the updated water management plans, a larger percentage of the excess mine water would be reinfiltrated or consumed by crop production within the Boulder Valley Hydrographic Area.

Current plans are that no additional water would be discharged to the river in the future; however, as described previously, Barrick has approval from the Nevada Division of Environmental Protection to discharge up to 70,000 gpm to the river (after treatment, if necessary, to meet appropriate water quality standards). Barrick reserves the right to exercise this water management option should it become necessary. For the purposes of estimating potential future flow impacts to the Humboldt River and the sink, this analysis used the future discharge scenario based on the information provided for RTi's earlier work (1998) as depicted in Table 3.2-26. This is considered to be environmentally conservative since it accounts for a higher discharge volume over time than is currently planned.

In order to assess potential future impacts of Barrick's mine discharges to the Humboldt River, Barrick's dewatering discharge scenario was simulated by computer modeling (RTi 1998). The scenario modeled by RTi (1998) included the effects of irrigation withdrawals and returns using the StateMod model (Colorado Division of Water Resources 1996). USGS streamflow data were used as a basis of comparison for an average flow year, high-flow year, and low-flow year.

The StateMod river simulation approach was used to analyze a potential maximum discharge scenario (RTi 1998). In this approach, changes to river flows were estimated by superimposing the monthly mine flows from the maximum predicted cumulative year of dewatering discharge (Table 3.2-26) onto the river flows and running the StateMod computer model. These simulations were conducted for a historic average year, a historic low-flow year, and a historic high-flow year based on streamflow records and data for the period 1946 through 1990. The simulation accounted for seasonal irrigation diversions and returns assuming that future irrigation diversion rates remained similar to historic values (Natural Resources Conservation Service 1997).

For RTi's quantitative evaluation of the Humboldt River upstream of Comus, the average return flow percentage was assumed to be 30 percent, which is midway between agency estimates of return flow percentages (see Section 3.2.1.3). The impact analysis presented for the project is very sensitive to the return flow percentage. Since this number is not known to have been determined explicitly either through experimental or analytical means for the Boulder Flat region or other regions included within the Carlin to Comus reach of the Humboldt River, the 30 percent

**Table 3.2-26**
**Modeled Maximum Goldstrike Mine Discharges to the Humboldt River (monthly average rates)**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CFS | 137 | 137 | 137 | 0 | 0 | 0 | 5.4 | 5.4 | 5.4 | 137 | 137 | 137 |
| GPM | 61,435 | 61,435 | 61,435 | 0 | 0 | 0 | 2,422 | 2,422 | 2,422 | 61,435 | 61,435 | 61,435 |

Source: RTi 1998.

return flow percentage used in the subsequent analysis represents a reasonable approximation based on agency estimates (Natural Resources Conservation Service 1997; Testolin 1997).

Average Seasonal Hydrograph Simulation Results. This section describes the effects of the projected discharges to flows in the Humboldt River. As analyzed by RTi (1998), the results presented in Figures 3.2-36 (RTi 1998) and 3.2-37 (RTi 1998) illustrate the simulated flow changes associated with a potential maximum annual discharge. As analyzed by RTi (1998), the results presented in Figures 3.2-36 and 3.2-37 illustrate the combined flows in the river that are predicted at Battle Mountain and Comus when the maximum cumulative mine discharges (Table 3.2-26) are simulated along with a historical average river flow. At the Battle Mountain gage, October shows the largest relative increase in flow (433 percent). The peak flow months of April, May, and June show little relative change at the Battle Mountain gage. In particular, the peak flow for June shows a negligible increase in average flow (0.2 percent).

At the Comus gage, all months except April, May, and June show at least a 20 percent flow increase (and often much larger) in the simulations. The month with the largest relative change in flow is October (540 percent), followed by September, and November. Peak flow months of April, May, and June show negligible increases in average flow at the Comus gage (0.2 percent for June). Changes at Imlay are expected to be similar to the pattern at Comus, but on a smaller scale due to flow losses between the stations.

Low Water Year Simulation Results. As analyzed by RTi (1998), the results presented in Figures 3.2-36 and 3.2-37 illustrate the combined flows in the river that are predicted at Battle Mountain and Comus when the maximum cumulative mine discharges (Table 3.2-26) are simulated along with a historic low-flow year (represented by 1959 historical data). The simulation shows that there is a large relative change to the average monthly flows for the late summer and fall months at both the Battle Mountain and Comus gages under the maximum discharge scenario. The most notable change to the low-flow hydrograph is the shift of water to the low-flow period of October through February. Flow changes at Imlay are expected to be similar to the pattern at Comus, but on a smaller scale due to flow losses between the stations.

High Water Year Simulation Results. As analyzed by RTi (1998), the results presented in Figures 3.2-36 and 3.2-37 illustrate the combined flows in the river that are predicted at Battle Mountain and Comus when the maximum cumulative mine discharges (Table 3.2-26) are simulated along with a historic high-flow year (represented by 1984 historical data). The largest relative change in flows at the Battle Mountain gage occurs from October through December. The largest relative change in flows at the Comus gage occurs from September through December. Flow changes at Imlay are expected to be similar to the pattern at Comus, but on a smaller scale due to flow losses between the stations.

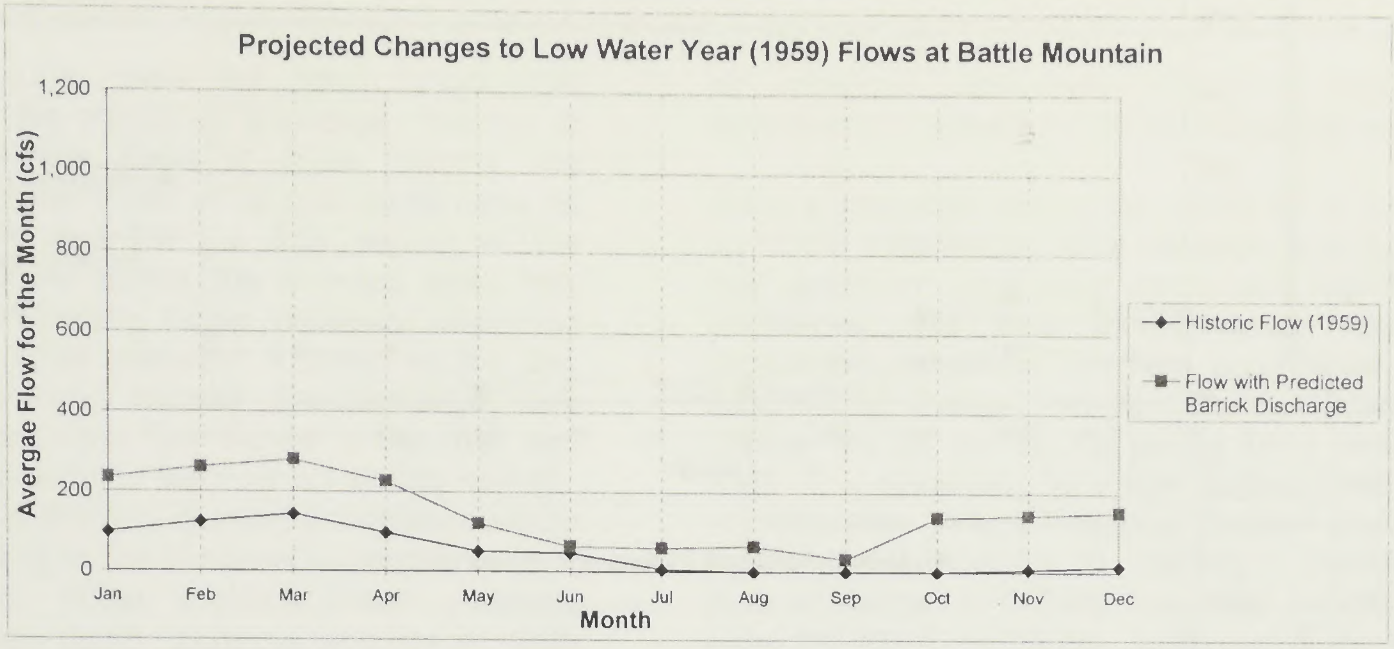
### Baseflow Changes in the Humboldt River from Dewatering Effects

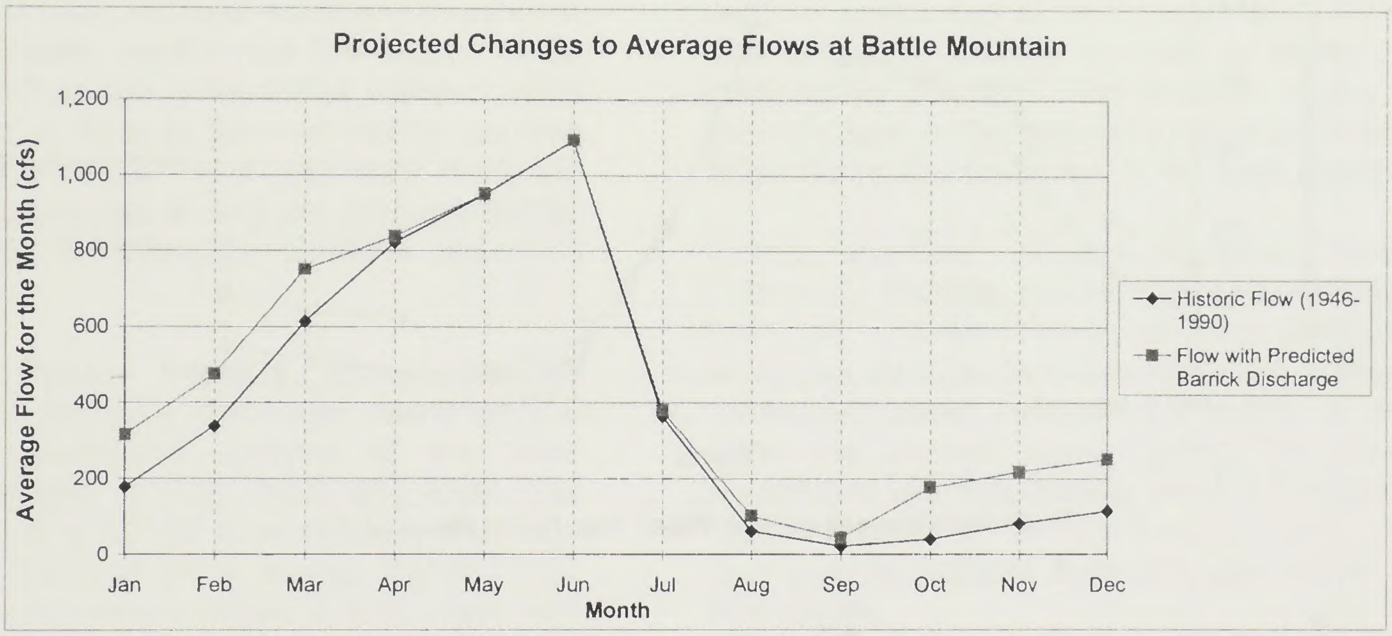
**Impacts to Date**. There is no evidence that before Barrick began discharging the Goldstrike Mine water management operations had either direct or indirect impacts on Humboldt River flows. As stated previously, historical flows (1946 to 1990) were compared to streamflow data after the initiation of pumping, and no conditions specifically attributable to dewatering were noted. Flows were lower throughout the Humboldt River basin in the early 1990s as a result of drought. Similar occurrences are observable in earlier periods of the historical record prior to mine dewatering.

**Projected Future Impacts**. Based on projected drawdown at the end of mining and 100 years postmining (Figures 3.2-23 and 3.2-25), substantial baseflow impacts to the Humboldt River from dewatering are not anticipated.

### Impacts to Flooding and Flow Geometry from Mine Discharges

**Impacts to Date**. As discussed in Impacts to Date to Humboldt River Flows, additional mine discharges may have increased Humboldt River flows. Generally, the high-flow months, such as


Projected Changes to Low Water Year (1959) Flows at Battle Mountain


Projected Changes to Average Flows at Battle Mountain

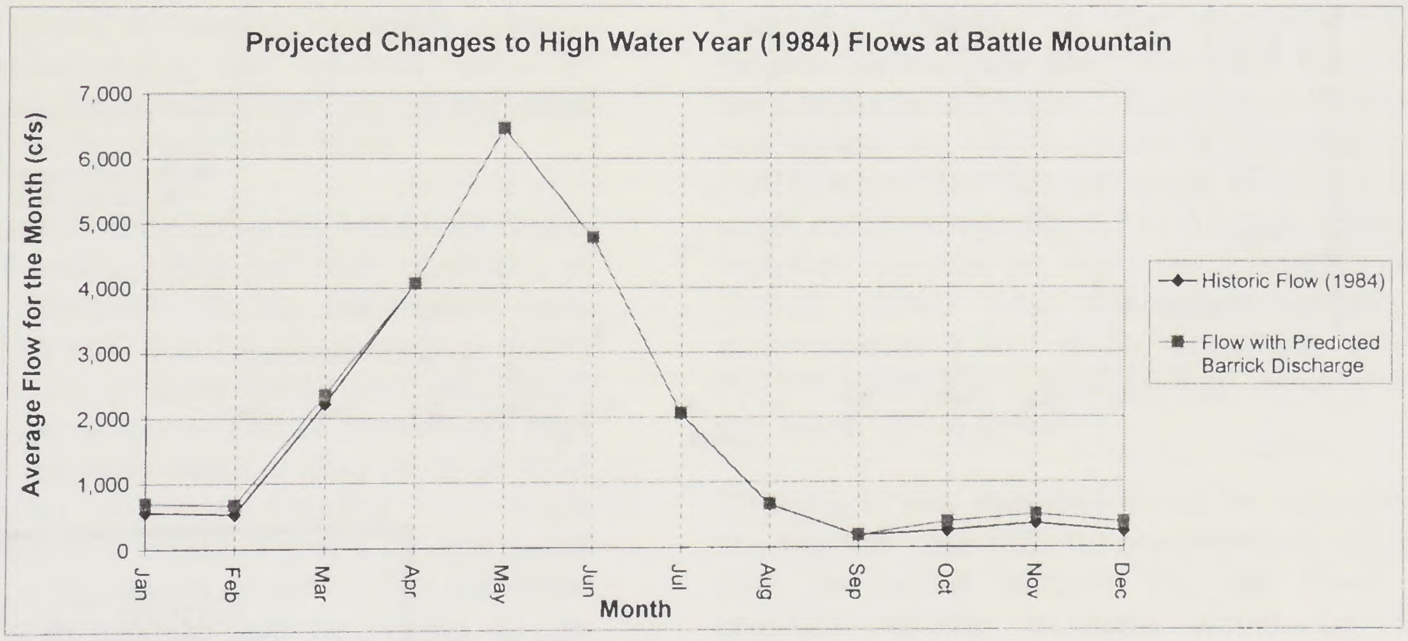

Projected Changes to High Water Year (1984) Flows at Battle Mountain

Figure 3.2-36

Projected Changes to Flows at Battle Mountain

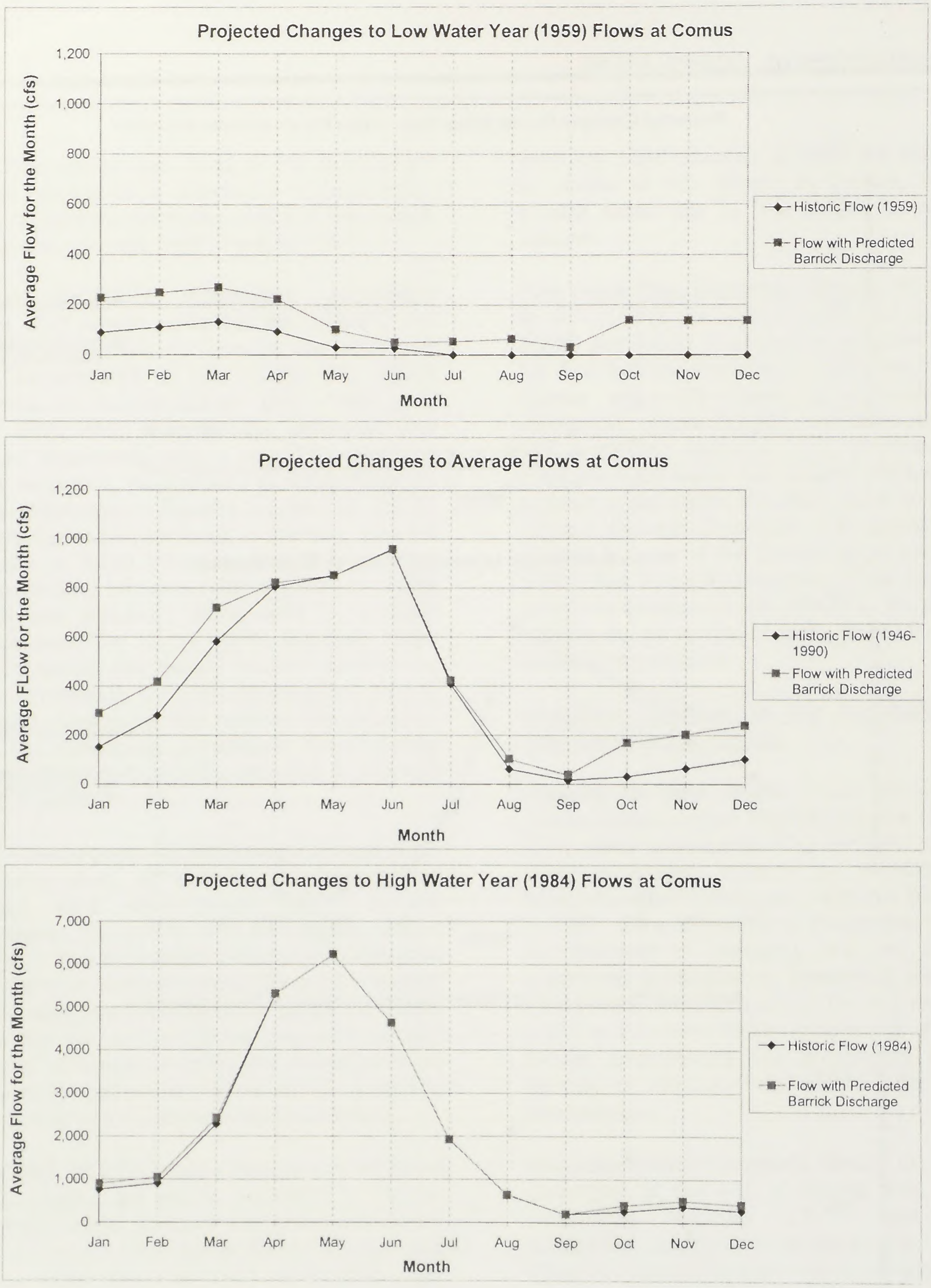


Figure 3.2-37

Projected Changes to Flows at Comus

May and June, have not been substantially affected by the additional discharge. Relative to the natural river flows in those months, the possible increases are small and would have no substantial impact on the flow regime of the Humboldt River during the average peak flow months. Comparably larger increases relative to the natural flows probably occurred in the low-flow fall and winter months. The discharges may have increased the flow depths in the river and added to the width of the river in low-flow months. The extent of the flow geometry increases would vary according to the cross-sectional geometry of the channel. Wider sections would generally undergo less depth increase and more width increase; narrower sections would experience the opposite. Greater depths and flow extent would generally reduce the potential for isolated pools or branches to form in the river during low-flow periods. Changes in flow geometry from the effects of discharges to-date are probably similar (or less) to the projected changes described below.

**Projected Future Impacts**. Based on the modeling of Barrick's discharge scenario (RTi 1998), a generalized analysis of the mine discharge effects on flow depth and width was conducted using USGS flow measurement data and stage-discharge rating curves. Table 3.2-27 shows the anticipated changes in river stage from the projected maximum mine discharges (Table 3.2-26). As shown in the table, negligible changes are anticipated during the high-flow month of June, but more substantial changes are expected during the low-flow month of October.

These increased flows generally would not create additional flooding along the river upstream of Rye Patch Reservoir. During the highest peak flows (such as may occur during a week in spring in some years), or along constricted reaches of the river during a longer period of relatively high flows (such as may occur during June in most years), limited additional flooding may occur where a change in depth of 1 foot or less would allow the river to escape its banks. The additional inundated area would likely be limited to the immediate vicinity of the river and would generally involve lower elevation hayfields and meadows. The potential for additional flooding downstream of Rye Patch Reservoir is complicated by seasonal streamflow forecasting and its effects on reservoir operations and the regional agricultural infrastructure, as discussed below.

Using a discharge versus river width curve based on USGS information, other potential changes in flow geometry were also examined. High-flow discharges, and thus widths, would remain unchanged. However, low-flow geometries are expected to change. Average October flows at Comus are 32 cfs for the period 1946 through 1996. This translates to a flow surface width of approximately 34 feet. Projected October average flow under conditions of maximum combined mine discharges is 169 cfs. For these conditions, using the same discharge - width curve, the flow width is anticipated to be approximately 72 feet. The calculated change in width is 38 feet. For comparative purposes, this analysis shows that the increases in flow geometry would be relatively larger during low flows than in the peak months.

During low-flow periods (August through February), flooding outside the streambanks is extremely unlikely. Additional mine discharges would not change that condition. The additional discharges would increase the extent of water within the channel banks during the low-flow season and would potentially provide connections between reaches or backwaters that would otherwise be isolated from one another at low-flow stages.

Hydraulic modeling at the discharge outfall location on the river has been done for a mine discharge rate of 156 cfs (70,000 gpm) (Simons & Associates, Inc. 1997). Simons & Associates, Inc. (1997) found that this discharge would cause a water depth increase of 0.1 to 0.2 foot during the high-flow months on the river (generally April through June) and a depth increase of approximately a foot or so during the low-flow months (generally August through November) in the vicinity of the outfall.

Changes in flow velocities would be moderate for the low-flow case (50 cfs) depending on distance from the outfall location. For low flows, the greatest velocity increase would be from approximately 2 feet per second without the discharge to approximately 3.25 or 3.5 feet per second with the discharge. This would occur both upstream and downstream of the outfall (Simons & Associates, Inc. 1997). In general, however, the

Table 3.2-27

Potential Changes in River Stages from Projected Maximum Goldstrike Mine Discharges

| USGS Streamgage | Month | Mean Observed Discharge 1946-1990 (cfs) | Observed River Stage 1992-93 Rating (feet) | Mean Simulated Discharge (cfs) | Simulated River Stage 1992-93 Rating (feet) | Simulated Change in Stage (feet) |
|---|---|---|---|---|---|---|
| Battle Mtn. | June | 1,093 | 6.56 | 1,095 | 6.56 | 0.0 |
| | October | 41 | 3.40 | 177 | 4.21 | 0.81 |
| Comus | June | 956 | 6.80 | 958 | 6.81 | 0.01 |
| | October | 31 | 2.49 | 169 | 3.55 | 1.06 |

Source: USGS 1998b; RTi 1998.

velocity changes would be substantially less than this. For a September case, with low flows on the order of 15 to 20 cfs, the relative change would be greater. For higher natural flows on the river (500 to 2,000 cfs), modeling indicates that historical velocities near the Barrick outfall have ranged from approximately 1 to 6 feet per second, depending on the flow rate and the specific cross section of the river (Simons & Associates, Inc. 1997). Modeling indicates that over the range of higher natural flows, streamflow velocities at the same cross sections would be virtually unchanged with Barrick's added discharge.

### Impacts to Channel Characteristics and Controls

**Impacts to Date.** Effects related to stream erosion, sedimentation, and channel geometry from the discharges are likely to have been small. The Humboldt River channel naturally undergoes large-scale erosion, sedimentation, and position shifts below the point where mine discharges are combined at the Barrick outfall. Qualitatively, the effects of mine discharges are expected to be less than those associated with other man-made causes, such as grazing and other land uses, or natural processes.

Channel stability impacts to-date from recent historical mine discharges of up to approximately 57,000 gpm (127 cfs) have not been documented. However, the release of over 100 cfs of relatively clear (sediment-free) water for approximately 3 months during the low-flow time of year has likely induced additional deepening and possibly widening of the low-flow section of the river channel. Similar impacts would likely result from future discharges.

**Projected Future Impacts.** If mine discharges occur in the future, they would intensify existing channel instability in the reach extending approximately 3 miles upstream and downstream from the Barrick outfall. Depending on flow velocities and the type of channel disturbance, adjustments may occur both upstream and downstream of the disturbance. Both upstream and downstream effects may occur because of overall adjustments in the channel system throughout the locale. Additionally, if the mine discharges, existing instability along the river near the Comus gage and immediately upstream may be exacerbated. Low-flow channel expansion (deepening and/or widening) is likely to be the most noticeable effect, since low flows would be most affected by future mine discharges.

These channel effects would probably be obscured or obliterated by subsequent spring runoff. Average annual peak flows in the river are approximately 1,100 cfs, and the bankfull flow (recurrence interval of 2.33 years) is estimated to be approximately 1,500 cfs in the river reach between Dunphy and Argenta. Over time, these peak flows would have a greater influence on overall channel morphology and sedimentation than the smaller mining discharges. As discussed previously, the relative increases in mean annual peak discharges from the mine dewatering are not expected to be substantial. Sediment deposition that may occur during the low-flow season would likely be entrained in the higher spring runoff flows.

### Impacts to Rye Patch Reservoir Operations and Irrigation Operations Downstream

**Background.** Rye Patch Dam and Reservoir are part of the Humboldt Project, which was authorized by Congress to provide irrigation water to approximately 40,000 acres of agricultural land in the Lovelock Valley (Bureau of Reclamation 1995). Construction of Rye Patch Dam was completed in 1936, and in 1941 the operation and maintenance of all Humboldt Project facilities, including the dam, reservoir, conveyances, and other facilities, were transferred by the Bureau of Reclamation to the Pershing County Water Conservation District. The locations of Rye Patch Reservoir and the Lovelock area are shown in Figure 1-6.

The greatest potential for adverse impacts to Rye Patch Reservoir and irrigation district from mine water discharges occurs in high water years. In normal and dry years, a positive impact is derived from the benefit of additional flows (Hodges 1998). Normally, additional water can be stored in the reservoir and distributed among the adjudicated rights with beneficial results.

**Impacts to Date.** Adverse impacts could result in high-flow years from additional flows exceeding the reservoir storage limitations and conveyance capacities of the canals and gates. Releases from Rye Patch Reservoir above 1,500 cfs create damage to the irrigation infrastructure and cause flooding of agricultural fields (Hodges 1998). When high flows are not accurately predicted on a seasonal basis, mining discharges can exacerbate the problem of operating Rye Patch Reservoir to preserve emergency storage and minimize flooding and structural damages downstream. If storage conditions at Rye Patch Reservoir were such that flows from upstream had to be directly passed through the reservoir, an additional 100 to 200 cfs in the river from mine dewatering discharges would take up approximately 7 to 14 percent of the 1,500 cfs drain capacity that could otherwise have been used to convey flows downstream without damaging the irrigation infrastructure.

The tops of the spillway gates at Rye Patch Dam are the highest elevation at which the reservoir can control releases to the river downstream. Gaging data at the reservoir for 1997 indicate that the pool elevation was within 1 foot of the top of the gates from mid-June until the third week of August. In addition, the reservoir pool was at or above the controlled storage elevation (the tops of the spillway gates) from June 30 to July 11, and again from July 26 through August 10 (USGS 1998a). None of these circumstances was a result of Goldstrike Mine discharges to the river, which did not begin until September 1997.

For 3 weeks in June 1998, Rye Patch Reservoir operated at very high storage levels. During this time, the reservoir reached its highest level on record (USGS 1999). For approximately 2 weeks, flow passed over the gates, placing a storage surcharge on the reservoir and allowing essentially uncontrolled discharge to the river and agricultural areas downstream. Flow in the river downstream of Rye Patch Dam reached approximately 2400 cfs. Barrick discharged approximately 130 cfs to the river during the previous winter and spring. It is possible that some of the mine dewatering discharge contributed to high-flow conditions at Rye Patch Reservoir and downstream, and thus contributed to impacts from excess water in these locations. The degree of Barrick's contribution is difficult or impossible to assess, since rainfall and river flows were exceptionally high on a regional basis during this period (see Tables C-9 and C-10, Appendix C). Barrick's nominal discharge represents approximately 5 percent of the flow in the river below Rye Patch Dam during the June period, but actually would have been much less due to attenuation and withdrawals between the location and timing of the dewatering discharge and the conditions at the reservoir.

**Projected Future Impacts.** As discussed above, Barrick currently does not intend to discharge dewatering water to the Humboldt River. However, under the terms of its NPDES permit, Barrick could discharge up to 70,000 gpm to the Humboldt River at its discharge outfall from 1999 through the end of mining. Therefore, this SEIS analyzes a dewatering discharge scenario provided by Barrick in 1997 (RTi 1998), as discussed previously under "Projected Future Impacts to Humboldt River Flows."

In normal to wet years, agricultural lands in the Humboldt Sink area may be flooded (Hodges 1998). In former years, river flows during August and September generally could be held at Rye Patch Reservoir, and downstream flooding could be minimized. The Nevada State Engineer has determined that any additional flows in the river are to be passed through the reservoir. If Barrick discharges in the future, this discharge may add mine water to naturally-occurring high-water conditions during wet years. The additional flow contributed by Barrick could combine with natural runoff phenomena to produce higher risk of damage to reservoir infrastructures or lands below Rye Patch Reservoir.

It is important to recognize that predicting surface water supplies from year to year is a difficult task, and a number of natural and man-made variables influence seasonal water storage and availability in the region. If additional discharges occur to the river from Barrick's mine water management program, whether or not they would produce adverse or beneficial impacts would depend on complex interactions between natural hydrologic variability and the responses of water managers. However, based on Barrick's recent projections, it is unlikely that Barrick would need to discharge excess mine dewatering water to the Humboldt River (Barrick 1999b). Therefore, impacts to Rye Patch Reservoir operations and irrigation operations are unlikely.

### Impacts to Water Levels at the Sinks

**Impacts to Date**. The Goldstrike Mine discharges have totaled approximately 81,000 acre-feet between September 1997 and February 1999. Approximately 49,000 acre-feet were discharged during calendar year 1998. Of this volume, approximately 35,000 acre-feet were released during non-irrigation periods, and approximately 30 percent of the remainder (4,200 acre-feet) eventually returned to the river. Some or all of this water (39,200 acre-feet) was probably lost to channel seepage, evapotranspiration, or other consumptive uses. Between Battle Mountain and Imlay, approximately 65,000 acre-feet/year were lost from the river system as an average from 1946 to 1990. An additional 20,000 acre-feet/year are estimated to be lost at Rye Patch and Pitt-Taylor reservoirs through seepage and evaporation (Eakin 1962), and further losses from seepage, diversions, and evapotranspiration occur below Rye Patch. Thus, generally very little of the mine discharges may have reached the sinks.

**Projected Future Impacts**. For the Humboldt Sink, general estimates of evapotranspiration and occasional outflows to the Carson Sink are on the order of 110,000 acre-feet/year, including approximately 57,000 acre-feet passing the Lovelock gage on the river, approximately 43,000 acre-feet from irrigation returns, and 11,000 acre-feet from direct rainfall. Barrick's current projections indicate that it is unlikely that Barrick would need to discharge excess mine dewatering water to the Humboldt River in the future (Barrick 1999b). In the unlikely event that it becomes necessary for Barrick to discharge at a high rate (such as up to 70,000 gpm) for an extended period (several months), depending on the season and natural flow contributions, it is possible that Barrick's discharge could incrementally contribute to temporary effects in terms of greater water depths and areal extent at the Humboldt Sink and possible spillover into the Carson Sink. Spillover into the Carson Sink historically has been a natural periodic occurrence. However, depending on the timing of the discharge, it is possible that only a fraction of the water would reach the sink due to losses from diversions, evaporation, evapotranspiration, and seepage in route.

### Impacts to Humboldt River Surface Water Rights

It is not anticipated that the additional mine discharges have created or would create major long-term impacts on surface water rights within the Humboldt River basin. Water resources within the basin have been over-appropriated historically, and the temporary nature of the discharges would not relieve that situation. It is possible that more existing rights may have been fulfilled to varying degrees during the period of mine discharges, or would be fulfilled during any future discharges if they occur. This would be a beneficial impact during the discharge duration. The amounts, locations, and timing of these further fulfillments would vary considerably depending on the seniority of rights and the volume of discharge. The further uses of water would depend largely on the existing agricultural infrastructure and future marketplace demands.

### Impacts to Water Quality

**Background**. In compliance with the provisions of the Clean Water Act, Barrick has an NPDES permit from the Nevada Bureau of Water Pollution Control authorizing dewatering discharges to the Humboldt River. Barrick's NPDES permit became effective on July 10, 1996, and expires on July 10, 2001, at which time the permit could be reauthorized for another 5-year period. Barrick's Boulder Valley outfall began discharging on September 16, 1997, and ended in February 1999 as illustrated in Figure 3.2-35. The NPDES permit (NV0022675) contains effluent limitations, monitoring and reporting requirements, and a list of conditions. The effluent limitations are designed such that water quality constituent concentrations would not exceed stream water quality standards established for the protection of identified beneficial uses.

**Impacts to Date**. Barrick's discharges recorded between September 1997 and February 1999 were within their permit limitations (no significant non-compliance). Significant non-compliance of an NPDES permit is defined by criteria that include: (1) exceedence of a 30-day average limit any 4 out of 6 months, (2) exceedence of a 30-day average limit by a factor of 1.4 or greater for any 2 out of 6 months, or (3) judgement of significant impact to human health or the environment by Nevada Bureau of Water Pollution Control Staff (Livak 1999). No significant non-compliance violation has been documented under the current NPDES operating permit (Livak 1999).

**Projected Future Impacts.** As stated in Chapter 1.0, Barrick currently does not anticipate future discharges to the Humboldt River. However, the mine's NPDES permit would allow for the discharge of up to 70,000 gpm on a year-round basis. Based on the discharged water quality to-date, it is assumed that if the mine were to discharge, the discharge water quality would meet the requirements of the NPDES permit limitations as it has in the past. Therefore, provided that the mine discharges are in accordance with the permit limitations, impacts to water quality in the river are not anticipated.

Even though the historic and any projected future mine discharges are anticipated to be within their permit limitations, there is concern that the mine discharge would contribute additional loads of inorganic constituents to the Humboldt River and eventually to the Humboldt Sink. If the mine discharge substantially increased the loads of inorganic constituents to the sink, these loads potentially would be available through evapoconcentration processes to increase concentrations in the sink.

As stated in Section 3.2, Affected Environment, the water quality of the Humboldt Sink wetland areas has been studied and monitored on an intermittent basis since 1987 jointly by the USGS and U.S. Fish and Wildlife Service (USGS 1991; Seiler et al. 1993; Seiler and Tuttle 1997). The studies concluded that arsenic, boron, mercury, molybdenum, sodium, un-ionized ammonia, selenium, and dissolved solids exceeded biological effects levels or Nevada standards for the protection of aquatic life. In addition, the U.S. Fish and Wildlife Service has identified arsenic, boron, chromium, copper, fluoride, lithium, manganese, mercury, molybdenum, selenium, thallium, uranium, zinc, and TDS as constituents of concern for the Humboldt Sink. Causes of contamination were identified as irrigation drainage, hydrogeologic setting, historic mining activities, and drought (Seiler and Tuttle 1997).

Database. Estimates of mine discharges to the Humboldt River for this loading analysis were based on actual historic discharges for the 1997 through 1998 period and estimated potential future mine discharges for the post-1998 period. Barrick (1997) provided an estimate of potential future discharges. In 1999, Barrick provided revised estimates of future mine discharges to the Humboldt River for the Goldstrike Mine (Barrick 1999b). Compared to the earlier estimates (Barrick 1997), the revised estimates indicate that the Goldstrike Mine would no longer discharge to the Humboldt River after the first quarter 1999 (earlier estimates assumed Goldstrike would discharge from 1999 through 2011). The reduction in discharge and change in discharge periods for the Goldstrike Mine reflect that under the updated water management plans, a larger percentage of the excess mine water would be reinfiltrated or consumed by crop production within the Boulder Valley Hydrographic Area. For the purposes of estimating potential load to the Humboldt River and the sink, this analysis used the discharge scenario based on the information provided in Barrick 1997. This discharge scenario, which has Barrick discharging an average of 25 cfs from 1997 through 2011, is considered to be environmentally conservative since it accounts for a higher discharge volume over time and correspondingly higher loads.

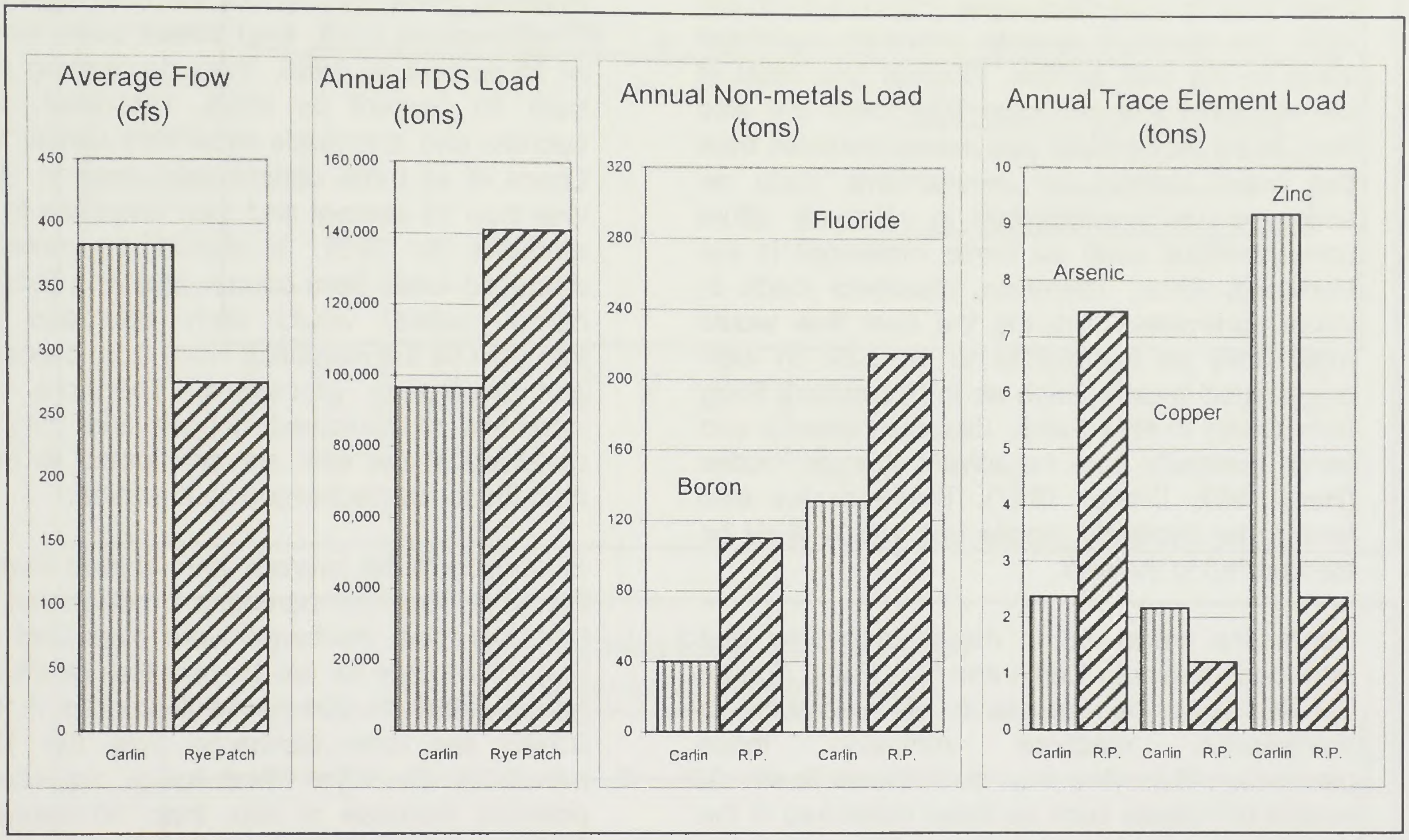
Available water quality information was compiled for the Humboldt River for all stations located between Carlin and the Humboldt Sink. For determining premine loading conditions, only samples for which both water quality and instantaneous river flow were measured at the time of sampling were considered. Water quality data are available for most of the gage sites shown in Figure 1-6. The most representative information on premine water quality in the Humboldt River exists for the Carlin gage for the April 1979 through April 1991 period, and at the Rye Patch gage for the October 1974 through July 1986 period (see Figure 1-6). Data from other water quality stations were much less complete and were not considered in this evaluation. The Carlin site was selected for evaluation since it represents conditions in the upstream reach of the Humboldt River study area. The Rye Patch site was selected to represent conditions in the lower portion of the river immediately above the Lovelock agricultural development.

Below the Rye Patch gage, a large percentage of river flows are diverted for irrigation. The Humboldt River and the Army Drain are the primary sources of flow to Humboldt Lake; the Toulon Drain is the primary source of flow to Toulon Lake. Only a few samples are available to define the load for each of these three sources of flow to the Humboldt Sink (Humboldt River immediately above the sink, Army Drain, and Toulon Drain) for the premine discharge period (prior to 1992). Because of the limited data, actual premine discharge load to the sink cannot be quantified. However, the data were used to qualitatively describe the relative potential increases in loads to the sink from the cumulative mine discharge.

Representative water quality data from recent discharge periods were used to estimate average constituent concentrations for Barrick's Boulder Valley outfall discharge. Of the constituents of concern identified by the U.S. Fish and Wildlife Service, water quality data were not available to calculate average concentrations of chromium, lithium, manganese, mercury, molybdenum, selenium, sodium, thallium, and uranium in the mine discharge. In general, either water quality data were not available for these constituents or meaningful average concentrations could not be calculated because the majority of the water quality analyses were reported to be below the detection limit.

Approach. Based on available data from the Humboldt River and the Barrick discharge, representative loads were calculated for TDS and dissolved arsenic, boron, copper, fluoride, and zinc. Using both the concentration of a chemical constituent in water and the associated flow rate or volume, the amount of the chemical constituent transported during a fixed time interval (or load) was calculated. Units of load are typically provided in pounds per day (lbs/day) or tons per year (tons/yr). These calculations were performed to estimate the premine loads in the river and the additional loads added to the river from the mine discharge. The estimated increased dissolved loads from the mine were then compared to premine conditions at various points along the river and at the sink. It is important to understand that the loads from the Barrick Boulder Valley outfall represent a maximum load that could be transported to the sink. As described below, for certain constituents (such as heavy metals), the actual load transported to the sink would likely be less than the initial loads delivered to the river at the outfall, since some of the load would be removed through adsorption or precipitation during transport.

Loads for TDS and dissolved arsenic, boron, copper, fluoride, and zinc in the Humboldt River prior to any discharges from the Boulder Valley outfall were evaluated at Carlin (above the mining area) and near Rye Patch (downstream of the Barrick Boulder Valley outfall and upstream from the Humboldt Sink). As can be seen in Figure 3.2-38, there is a substantial decrease in flow from Carlin downstream to Rye Patch. Figure 3.2-38 illustrates that between Carlin and Rye Patch there also is a decrease in dissolved



Comparison of the estimated average annual dissolved load transported by the Humboldt River at the Carlin and Rye Patch gages prior to mine discharges.

Figure 3.2-38

Estimated Average Annual Premine Loads at the Carlin and Rye Patch Gages copper and zinc loads, but an increase in TDS and dissolved boron, fluoride, and arsenic loads.

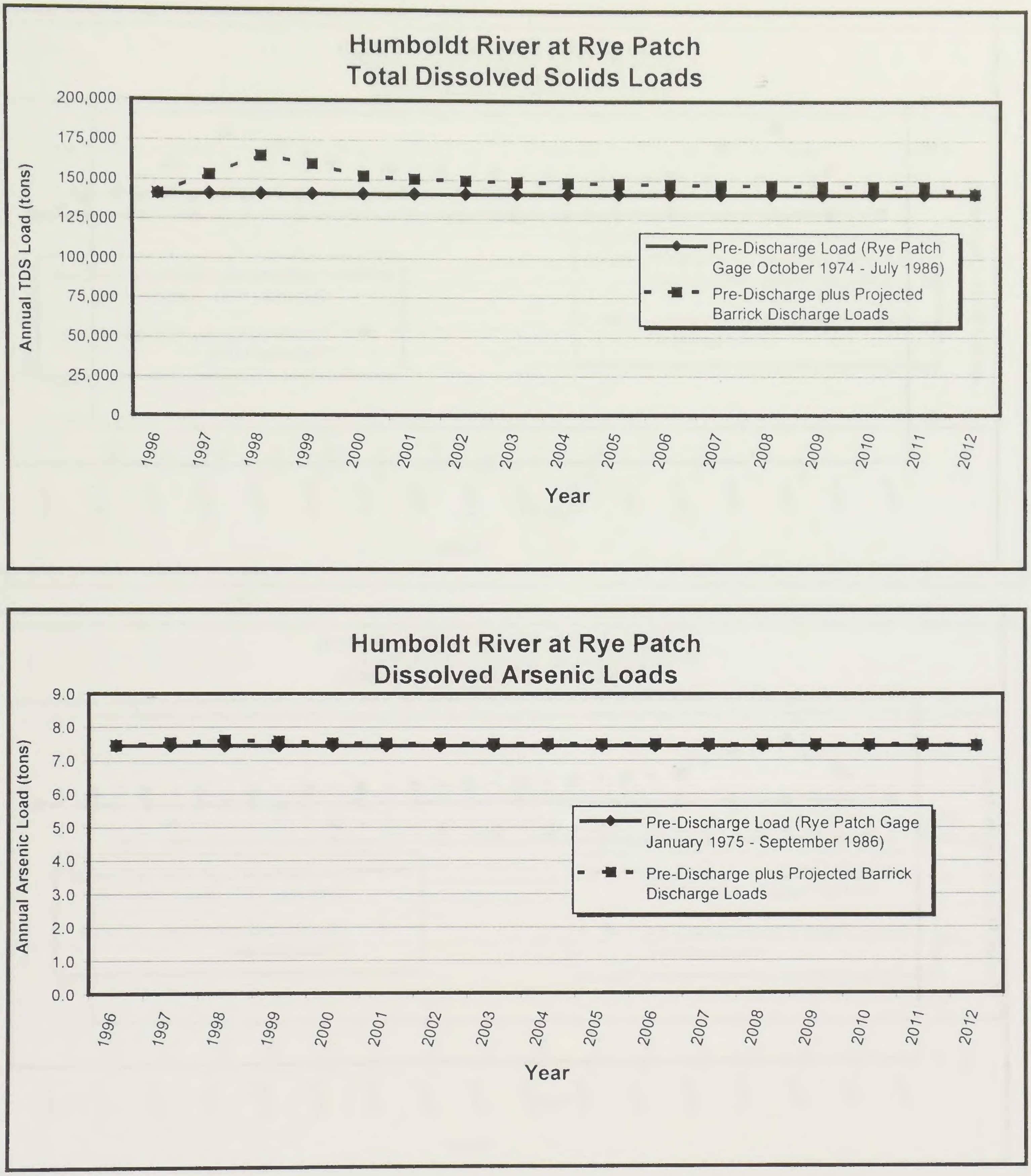
Increases in TDS, arsenic, boron, and fluoride loads prior to mine discharges (Figure 3.2-38) are likely the result of sources providing additional loads to the river section. Fluoride and most of the elements that influence TDS loads are also likely to be very mobile (not readily removed from the water column by mechanisms such as adsorption or precipitation) in relatively dilute concentrations such as those measured in the Humboldt River. Therefore, dissolved loads of these parameters entering the river flow would most likely be transported to the sink. In well-oxygenated waters, such as the Humboldt River from Carlin to Rye Patch, dissolved arsenic and boron generally form negatively charged oxides (Hem 1992; Drever 1997). These oxides also tend to be relatively mobile and would likely be transported to the sink.

Decreases measured in dissolved copper and zinc loads between Carlin and Rye Patch (Figure 3.2-38) could be the result of adsorption or precipitation reactions removing these parameters from the Humboldt River flows. At neutral pH values such as those measured in the river, these metals tend to form solid precipitates or adsorb onto suspended and sediment particles (Drever 1997; Hart and Hines 1995). Precipitates and suspended particles may then settle out of the water column, reducing the total metals load transported by the river. Figure 3.2-38 illustrates that only a fraction of these parameter dissolved loads introduced to the Humboldt River above the Rye Patch gage are likely to travel to the sink.

The average annual dissolved loads calculated for the Rye Patch gage were used to evaluate potential increases in load to the Humboldt River from the Barrick Boulder Valley outfall discharge. The Rye Patch gage was selected for evaluation since the main concern is potential increases in dissolved constituent loads downstream of the mine outfall and to the Humboldt sink. As shown in Figures 3.2-39, 3.2-40, and 3.2-41, for most years the loads from mine discharge represent only a slight increase when compared to premine loads at the Rye Patch gage. For the purposes of this discussion, all potential increases in dissolved loads are discussed in terms of the annual average relative percent increase over average premining loads. The difference in TDS load increases to approximately 17 percent in 1998, and then drops to negligible levels after 2000. The dissolved arsenic load remains relatively minor throughout the discharge period. The dissolved boron load shows peak increases of 35 percent in 1998, then decreasing to less than 10 percent by 2005. Dissolved copper, fluoride, and zinc loads show very similar trends. Loads of all three constituents peak in 1998 at less than 25 percent and then decrease to minor amounts by 2001. It should be noted that dissolved loads from copper and zinc (and other heavy metals) would likely decrease during transport by the Humboldt River from precipitation and adsorption processes. Therefore, actual increases in dissolved copper and zinc loads observed at the sink are anticipated to be less than the loads discharged by the mine.

In addition to the average annual load increases, the total potential increases in dissolved loads from the mine discharge were evaluated at the Rye Patch gage for the 15-year Barrick discharge period (1997 to 2011). As illustrated in Figure 3.2-42, the mine discharge over the 15-year period at the Rye Patch gage represents a potential increase of less than 10 percent for TDS, arsenic, copper, fluoride, and zinc and a 14 percent increase for boron. These increases at the Rye Patch gage represent dissolved loads that could potentially reach the Humboldt Sink during the mine discharge period.

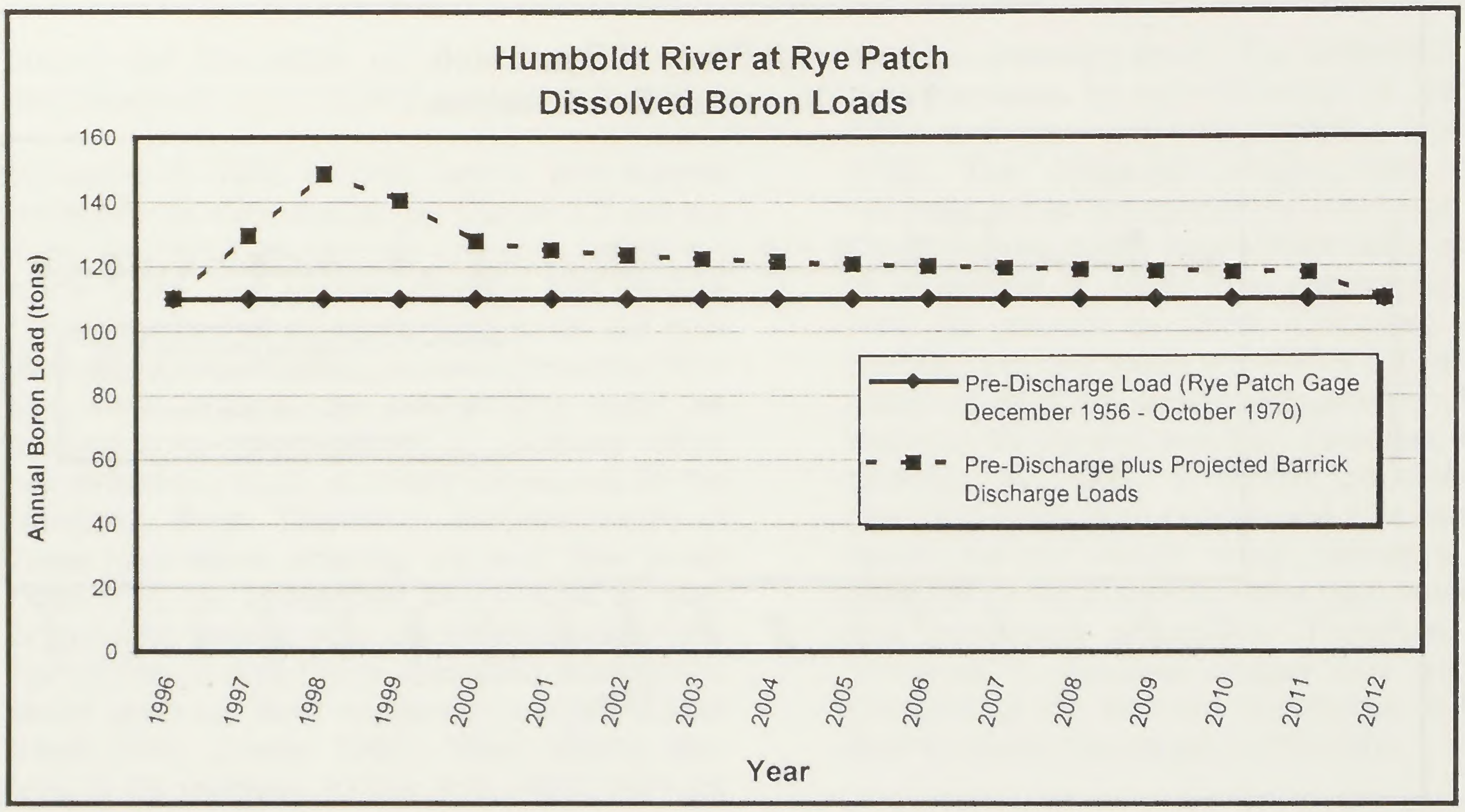
Potential Increases in Loads to the Sink from Barrick's Boulder Valley Outfall. Between the Rye Patch gage and the Humboldt Sink, a large percentage of the Humboldt River flows are diverted and routed through the Lovelock agricultural area. This diversion and return flow system includes approximately 50 miles of main canals, 100 miles of lateral drains, and 130 miles of open return channels (Seiler et al. 1993). Discharge from the agricultural drains is one of the primary sources of water to the sink. Discharge water from the drains historically has contained concentrations of TDS, arsenic, boron, mercury, molybdenum, sodium, and un-ionized ammonia; these concentrations have exceeded biological effects levels or Nevada standards for the protection of aquatic life (Seiler et al. 1993). The agricultural discharge results in a substantial

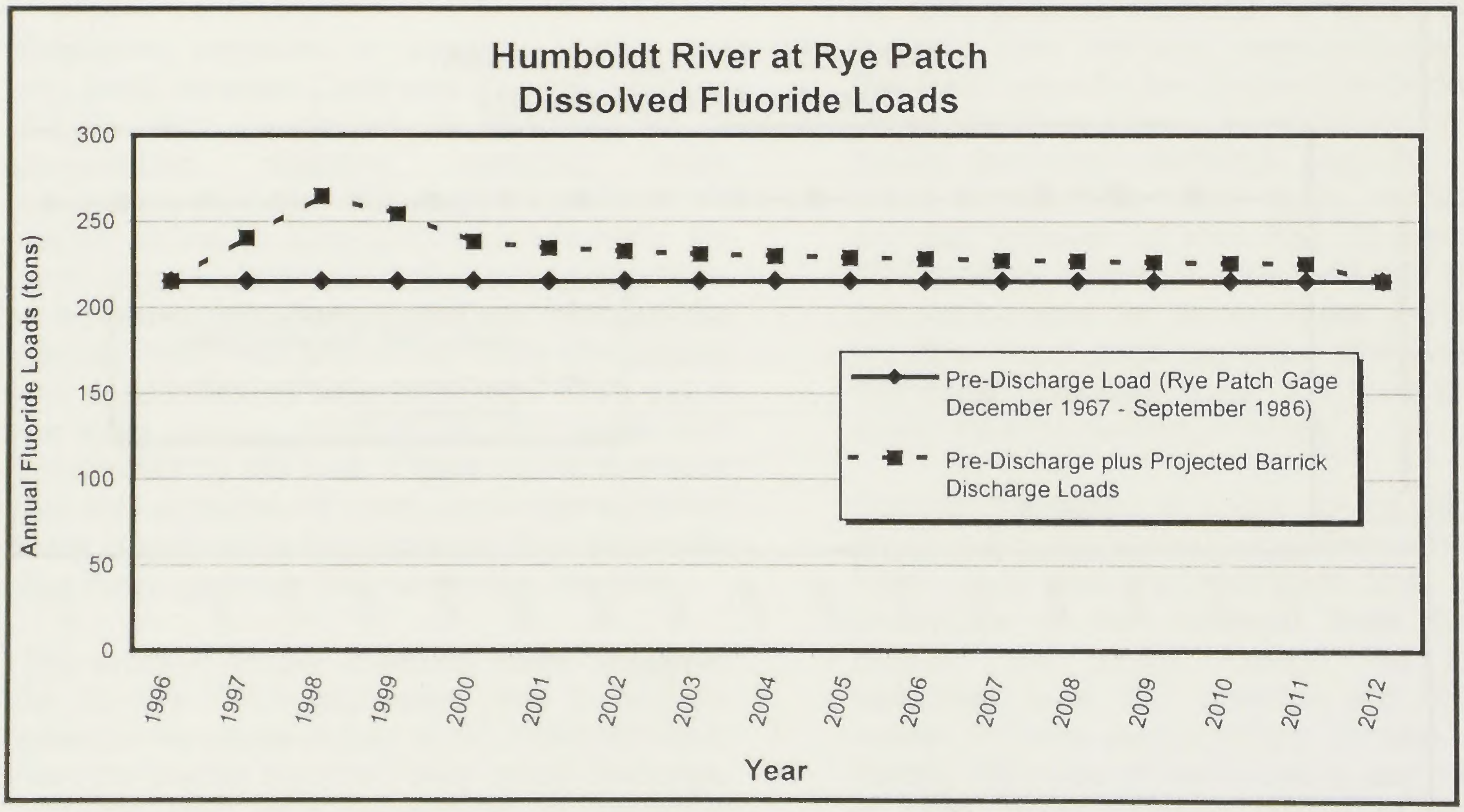


Potential maximum increases in annual loads of TDS and dissolved arsenic resulting from Barrick's historic and projected future mine discharges at the Rye Patch gage over the mine discharge period.

Figure 3.2-39

Potential Maximum Increases in Annual Loads of TDS and Arsenic at the Rye Patch Gage

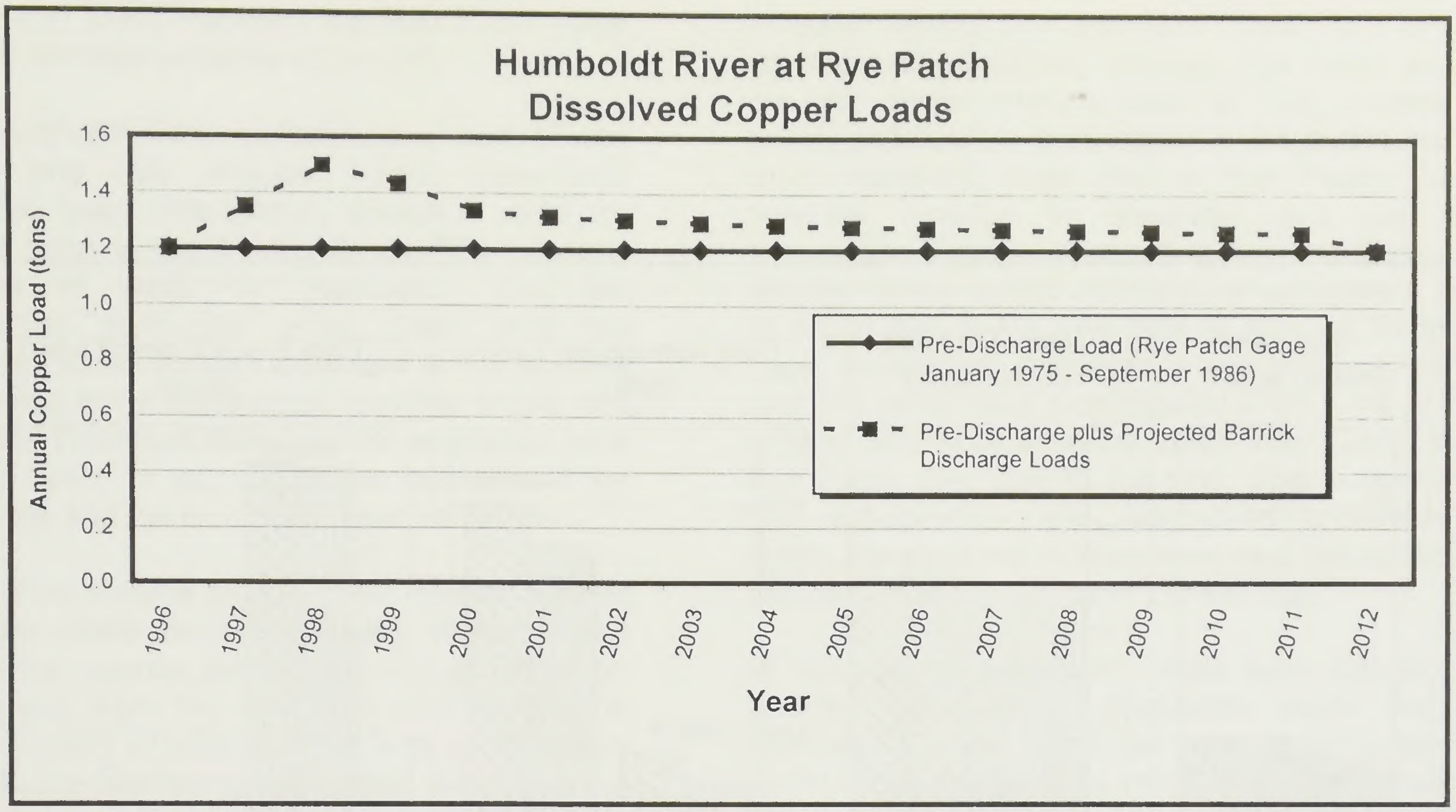


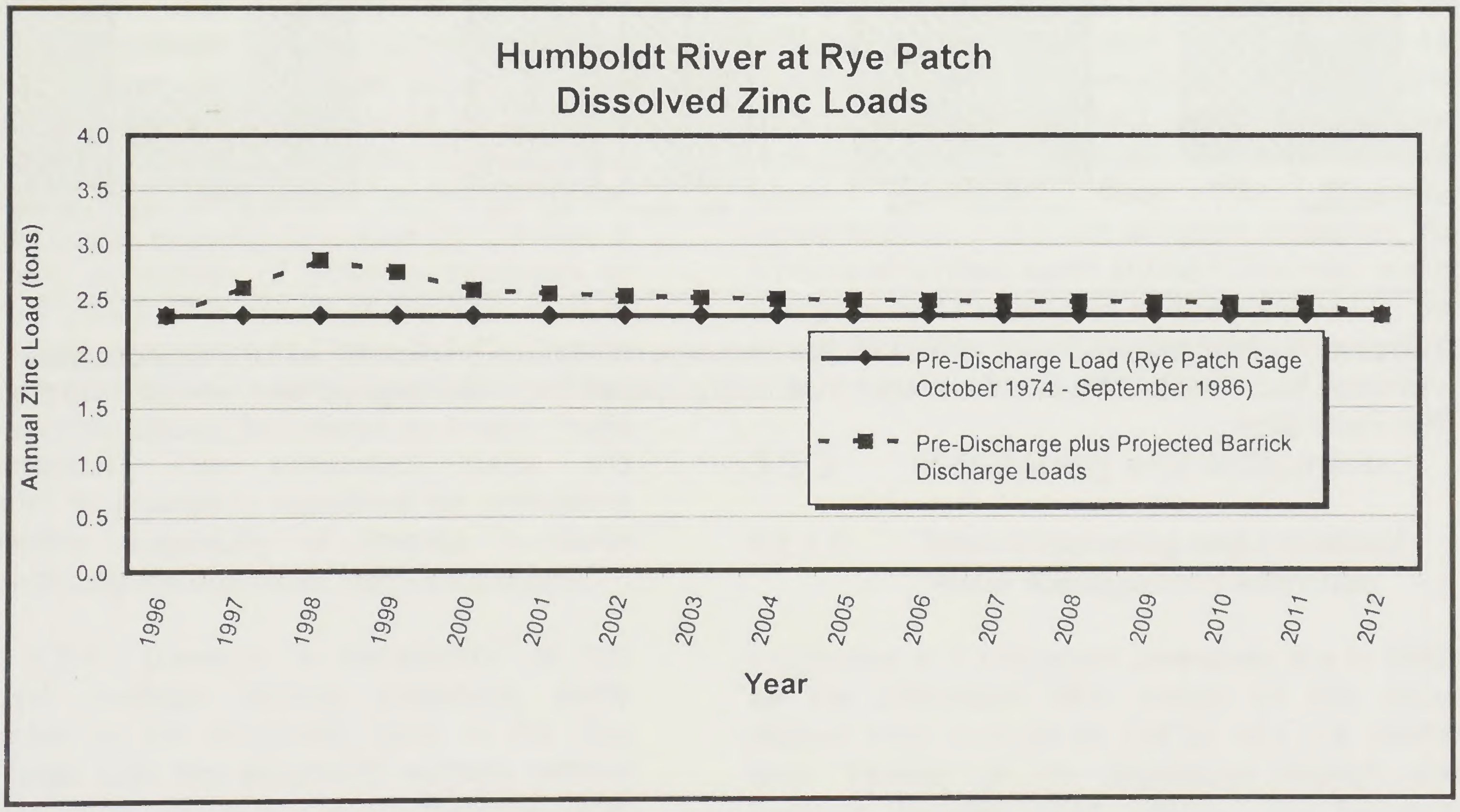


Potential maximum increases in annual dissolved loads of boron and fluoride resulting from Barrick's historic and projected future mine discharges at the Rye Patch gage over the mine discharge period.

Figure 3.2-40

Potential Maximum Increases in Annual Loads of Boron and Fluoride at the Rye Patch Gage

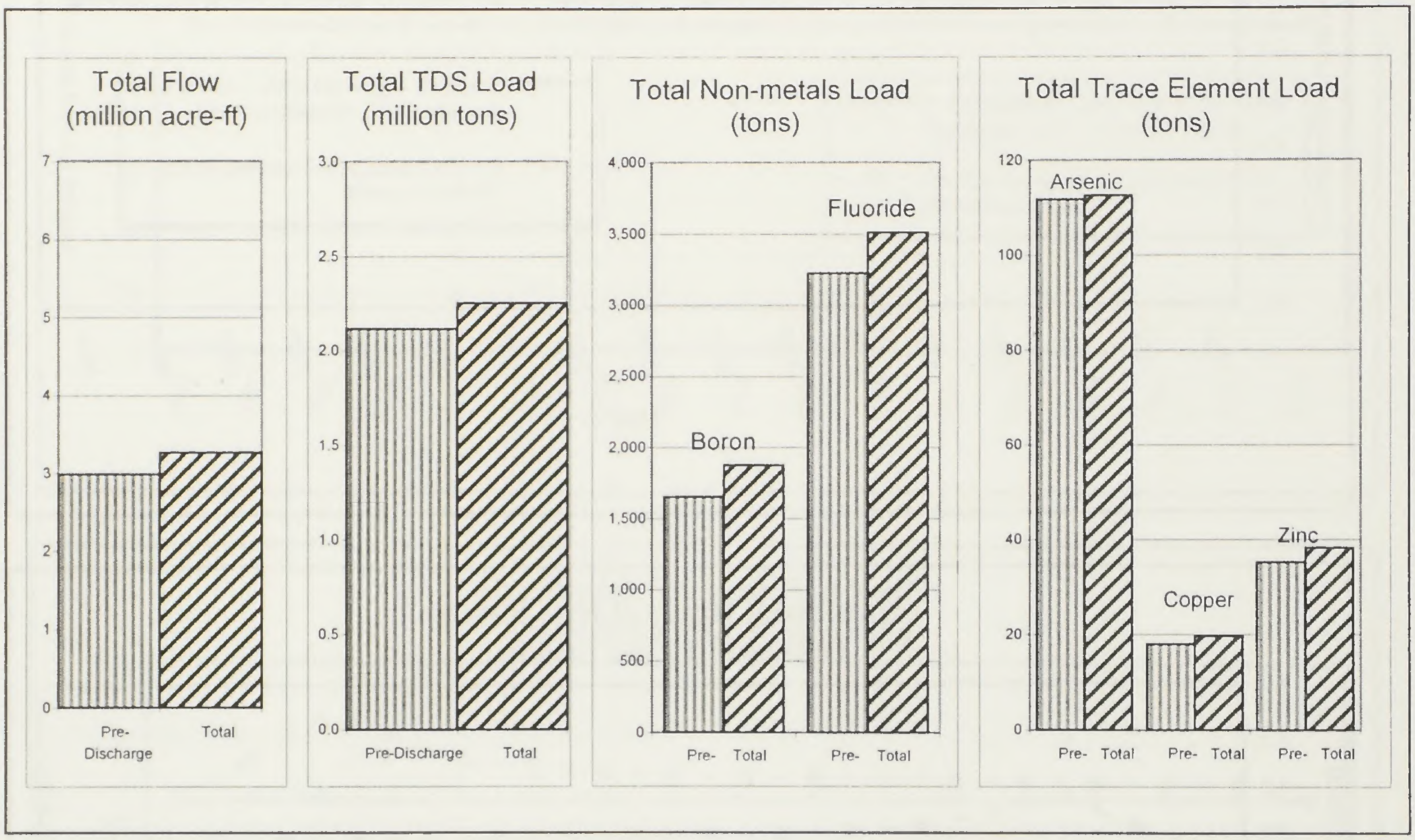




Potential maximum increases in annual dissolved loads of copper and zinc resulting from Barrick's historic and projected future mine discharges at the Rye Patch gage over the mine discharge period.

Figure 3.2-41

Potential Maximum Increases in Annual Loads of Copper and Zinc at the Rye Patch Gage



Comparison of the dissolved loads without Barrick discharge contribution (vertical fill) with the total postmine discharge loads (slashed fill) over the entire historic and projected future discharge period (1997-2011) at the Rye Patch gage.

Figure 3.2-42

Total Potential Increase in Loads During the Mine Discharge Period (1997-2011) at Rye Patch Gage increase in loads between the Rye Patch gage and the terminal wetlands at the sink.

The Humboldt Sink wetlands are part of the WMA, and they include Toulon Lake and Humboldt Lake. The primary source of water for Toulon Lake is the Toulon Drain. The principal sources of water for Humboldt Lake are discharges from the Army Drain and the Humboldt River. Actual discharges to the sink are not known since discharges from the drains and the lower Humboldt River are not monitored on a regular basis. In addition, water quality data for the drains and the Humboldt River are limited.

Streamflow records for the lower Humboldt River exist for 1950 to 1959. Using these limited monitoring records, the average annual discharge to the sink from the river was estimated to be approximately 57,000 acre-feet with an additional 42,000 acre-feet being discharged from irrigation return flows. A few water quality samples were taken between 1987 and 1990 at the Toulon Drain, the Army Drain, and the Humboldt River at Lovelock. These limited data were used to calculate a preliminary estimate of the premine loads entering the sink wetlands. The potential mine loads then were added to the estimated premine loads entering the sink to provide a preliminary evaluation of potential increases in loads to the sink. The results of this evaluation of the sink are presented in Figure 3.2-43. Due to the very limited data and simplifying assumptions, this evaluation should be viewed as a very rough approximation. The estimated loads are presented to provide a reference for evaluating the relative magnitude of change in loads represented by the combined mine discharges.

Figure 3.2-43 presents a comparison of the estimated average annual dissolved loads transported by the Humboldt River at the Rye Patch gage with the estimated average annual dissolved loads discharged to the Humboldt Sink (represented by the combined loads calculated for the Humboldt River near Lovelock, Toulon Drain, and Army Drain). Based on the available data, and the assumptions for discharge to the sink, there appears to be a major increase in TDS and dissolved arsenic, and boron loads between the Rye Patch gage and the point of discharge into the Humboldt Sink (Figure 3.2-43). This plot also suggests that dissolved fluoride loads increase slightly, and dissolved copper and zinc loads actually decrease between Rye Patch and the sink. Since premine loads of TDS, arsenic, boron, and fluoride were higher in the drains and lower Humboldt River than at Rye Patch, the potential increase in dissolved load (as a percentage of premine) resulting from the Barrick Boulder Valley outfall discharge is anticipated to be much less at the sink than at the Rye Patch gage. Substantial increases in dissolved copper and zinc loads are not anticipated since there is a general decrease in metal loads from Carlin to Rye Patch and then to the sink. This suggests that precipitation and adsorption processes during transport would likely remove a substantial percentage of the dissolved metals load.

In conclusion, constituent loads from Barrick's Boulder Valley outfall discharges would likely increase TDS and dissolved boron, and fluoride loads in the sink over the mine discharge period. However, the relative magnitudes of these potential increases do not appear to be substantial, as illustrated in Figure 3.2-44. Depending on concentrations in the sink, parameter solubilities, and other physical and biological factors, increased loads to the sink could potentially result in increased concentrations in the sink wetlands. However, the amount of surface water stored in the sink at any one point and the amount of flow received by the sink wetlands appear to be the primary controlling factors for water quality of the wetlands.

## 3.2.3 Monitoring and Mitigation

### 3.2.3.1 Mine Dewatering and Localized Water Management Activities

Monitoring and mitigation measures are in place for the Goldstrike Mine based on the Betze Project Final EIS (BLM 1991b) and the Meikle Mine Finding of No Significant Impact and Decision Record (BLM 1994c). The following monitoring and mitigation measures are proposed based on the potential water resources impacts identified in this Supplemental EIS.

Perennial Springs, Seeps, and Streams

A spring, seep, and stream monitoring program would continue for selected sites to monitor

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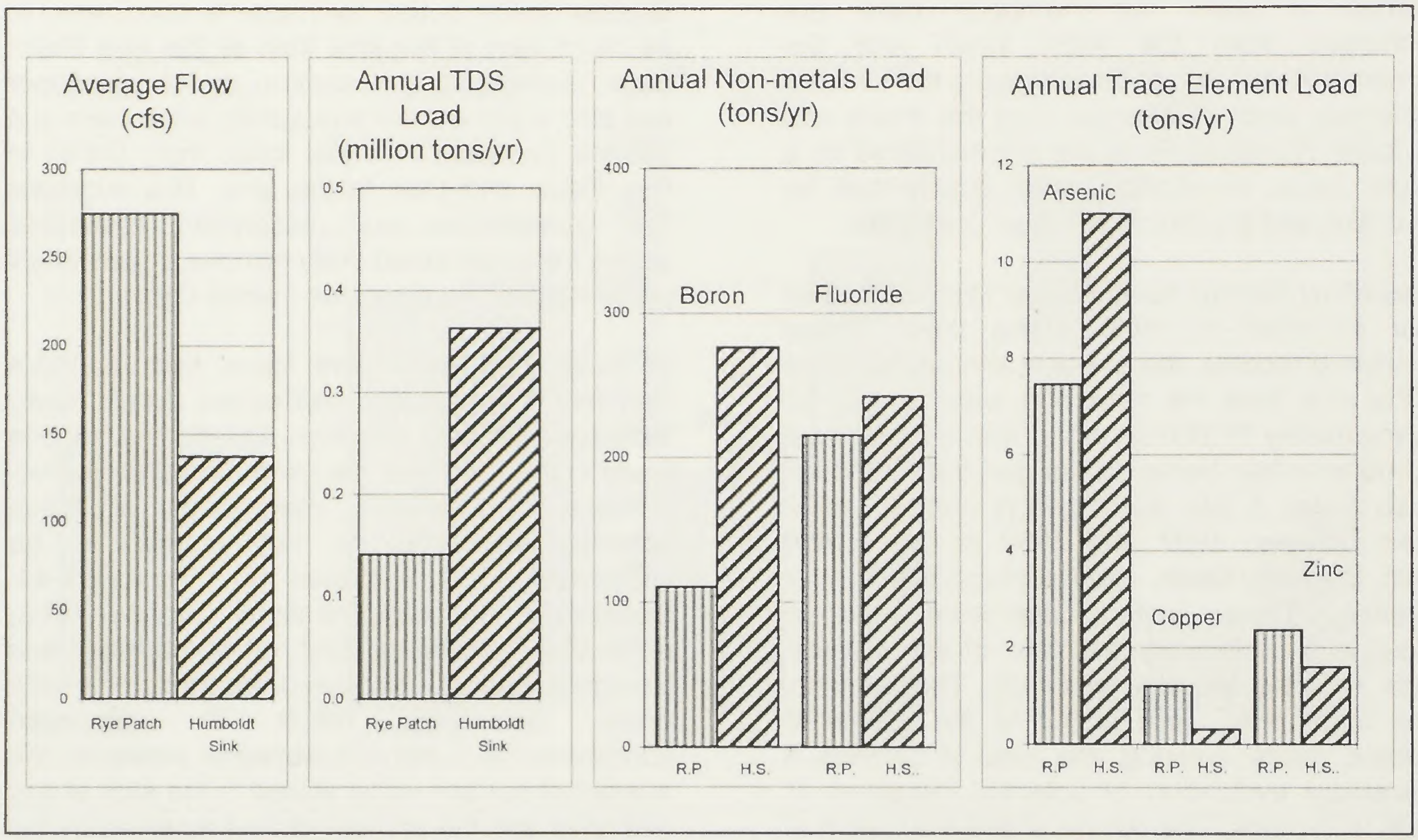
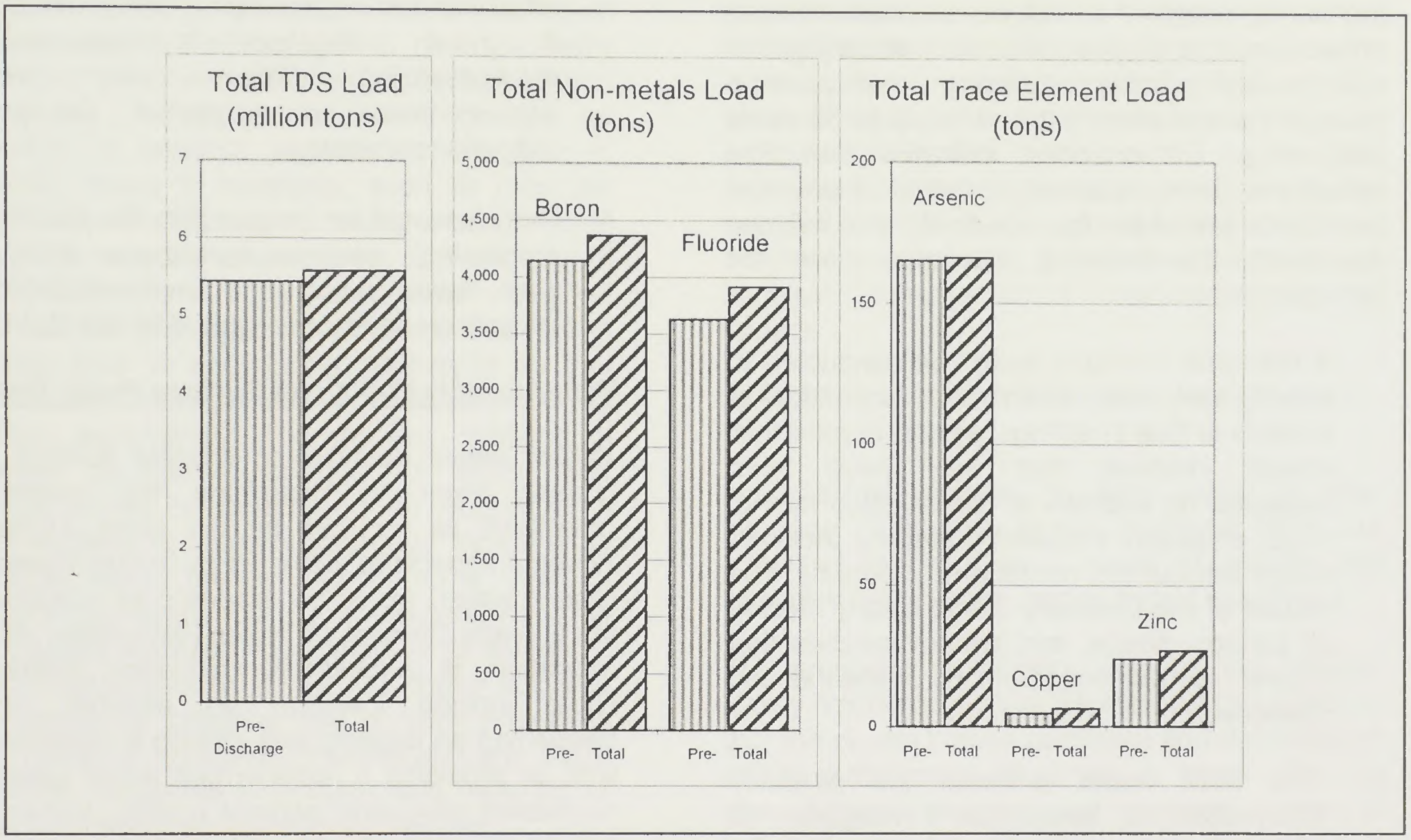


Comparison of the estimated average annual dissolved load transported by the Humboldt River at the Rye Patch gage with dissolved load discharge to the Humboldt Sink (Humboldt River near Lovelock, Toulon Drain, and Army Drain). Note that estimated loads discharged to the sink are based on very limited flow and water quality data.

Figure 3.2-43

Comparison of Average Annual Loads at Rye Patch Gage vs. Humboldt Sink (Premine Discharge)



Comparison of the dissolved loads without any Barrick discharge contribution (vertical fill) with the potential total dissolved loads during the discharge period (slashed fill) over the entire historic and projected future discharge period (1997-2011) at the Humboldt Sink. Note that 1) estimate of loads to the sink are based on very limited premine data; and 2) actual mine contributed loads reaching the sink could be less than total potential (see text for additional explanation).

Figure 3.2-44

Total Potential Increase in Loads During the Mine Discharge Period at the Humboldt Sink reductions in flow from mine dewatering activities. Reductions in baseflow could occur both during project operation and for an extended period following cessation of mining. Flow and water quality are monitored monthly at stream stations and annually in representative spring sites, and the results are provided to the BLM. This monitoring program would be reviewed at least annually and revised as necessary in conjunction with the BLM. Spring monitoring would continue through the end of mining and for up to 30 years postmining. If monitoring indicates that flow reductions have occurred and that these flow reductions are likely the result of mine-induced drawdown, the following measures would be implemented:

1. A resource inventory would be conducted to identify the areal extent and magnitude of impacts to flow in springs, seeps, or perennial stream reaches that may have been impacted (in addition to the selected spring, seep, or stream monitoring stations included within the current monitoring program). The results of the inventory would clearly identify all springs, seeps, and stream reaches that appear to be impacted by mine-induced drawdown.

2. The BLM would evaluate the available information to determine if mitigation is required. If mitigation is required, a detailed site-specific mitigation plan to repair or replace the impacted perennial water resources would be prepared. Mitigation would depend on the actual impacts and site-specific conditions and could include a variety of measures:

    - Augmenting or replacing flows by drilling well(s) and pumping, or piping water from other nearby sources to restore the average historic baseflow at the perennial water resource (seep, spring, or stream). Any replacement water source used to augment or replace flows would meet the water quality criteria applicable for the historic beneficial use (such as aquatic life, irrigation, or livestock watering).

    - On-site or off-site improvements including stream (or spring) bank stabilization, fencing to limit grazing, installation of guzzlers, or other measures, to enhance water yield.

3. An approved site-specific mitigation plan would be implemented, followed by monitoring and reporting to measure the effectiveness of the implemented measures. If initial mitigation is unsuccessful, the Authorizing Officer may require implementation of additional site-specific mitigation measures.

4. Barrick would be responsible for funding all monitoring, resource inventories, mitigation plan development, and implementation of mitigation measures required by the BLM.

**Water Supply Wells and Surface Water Rights**

Barrick would continue to monitor surface and ground water to determine the extent of drawdown as required by the State Engineer. Adverse impacts to water rights (surface water or ground water) would be mitigated as required by the Nevada Division of Water Resources. Where mitigation is necessary, mitigation measures could include lowering an affected pump, deepening an existing well, drilling a replacement well, or providing a replacement water supply of equivalent yield and general quality. Impacts to individual surface water right holders would be mitigated on a case-by-case basis as required by the Nevada Division of Water Resources.

### 3.2.3.2 Humboldt River Monitoring and Mitigation Measures

No further discharges to the Humboldt River are currently planned for Goldstrike Mine water management operations. As previously described, impacts to-date from previous discharges are minor and are within the normal historical range of flows and channel conditions for the river. USGS streamgaging stations are in place at Dunphy upstream of the discharge outfall and at Battle Mountain downstream. Sampling and characterization programs currently are in place as a result of state and federal permit approvals.

If additional discharges to the river are planned at some point in the future, Barrick would be responsible for periodically inspecting and surveying the river channel (in plan view as well as cross-sectionally) for approximately 1 mile upstream and 3 miles downstream of the outfall prior to the releases. Repeat measurements should occur on a periodic basis, as determined by discussions with federal and state agencies, to monitor changes in river characteristics before, during, and after the discharge period. This would allow a baseline assessment of river geometry trends and structural conditions to be established before the discharges and would provide an indication of possible impacts (or the lack of impacts). Areas of instability, such as meander cutoffs, accelerated bank erosion, or scour holes, should be noted and described. Contact should be maintained with other water users along the river (particularly agricultural users and water districts) prior to and during discharges so that their water management operations can be modified accordingly. The existing condition of diversion structures, bridges, or other river controls would be noted prior to discharge. If direct impacts to channel geometry trends or to structures along the river occur as a result of Barrick's discharges, Barrick would conduct repair or mitigation activities appropriate to its estimated level of responsibility. If needed, these activities may consist of installing bed or bank protection (e.g., riprap or articulated mattresses) and scour protection measures at bridges, and repairing or protecting other structures along the river.

## 3.2.4 Residual Effects

### 3.2.4.1 Mine Dewatering and Localized Water Management Activities

At the completion of dewatering activities, ground water inflow is predicted to result in the development of a pit lake in the Betze-Post Pit. After hydraulic steady-state is reached, evaporation would result in a net loss of approximately 2,700 acre-feet of water per year. Assuming a total recharge of approximately 19,300 acre-feet/year (McDonald Morrissey Associates, Inc. 1998) for the Boulder Flat Hydrographic Area, evaporation from the pit lake would represent a loss of approximately 7 percent of the total ground water recharge. This long-term change in the ground water balance is considered a residual impact.

The continuous inflow of ground water into the lake to replace water lost through evaporation is predicted to maintain a cone of depression that extends up to approximately 7 miles northwest and 11 miles south-southeast from the center of the Betze-Post Pit. This permanent drawdown would be maintained by continuous inflow of ground water into the pit lake to replace water lost through evaporation. Successful implementation of mitigation measures would eliminate most residual impacts to water resources. However, adequate mitigation measures for permanently reducing the rate of ground water discharge, or baseflow, at some spring and stream locations may not be available. A permanent reduction in surface discharge would constitute a residual impact.

### 3.2.4.2 Residual Effects to the Humboldt River

No residual impacts to flow rates or their seasonal distribution in the Humboldt River are expected to occur as a result of current and projected future water management operations.

The amended reclamation plan for the Boulder Valley discharge system (Barrick 1996b) specifies that the rip-rap placed upstream and downstream of the outfall pipe will remain in place after the rest of the conveyance and treatment system is removed and the disturbed area is reclaimed. This would temporarily stabilize the river position at that location for an unknown period of years or decades. Without inspection and maintenance, the bank and channel reinforcement would ultimately fail and the local river geometry would more or less return to its previous dynamic state. In the meantime, the river position may be held at the location of the riprap structure while meanders and cutoffs form elsewhere along the reach. This may accelerate lateral channel migration at other locations and structures immediately upstream and downstream of the remaining outfall structure.

## 3.2.5 Irreversible and Irretrievable Commitment of Resources

An estimated 1,085,000 acre-feet of water would be extracted during Goldstrike Mine dewatering and postmining pumping. Of this amount, approximately 440,000 acre-feet would be consumed by the mining and milling operation crop irrigation or lost from evaporation. The remaining approximately 645,000 acre-feet would be reinfiltrated or discharged to the Humboldt River system. The net reduction of ground water during the life of the project (440,000 acre-feet) is an irretrievable commitment of a ground water resource. It should be noted that this 440,000 acre-feet of water includes mine dewatering water consumed during crop irrigation in Boulder Valley. It is likely that much of this crop irrigation would have occurred (through ground water pumping in Boulder Valley) even without water provided by the Goldstrike Mine water management system.

The continuous inflow of ground water into the pit lake to replace water lost through evaporation is predicted to maintain a long-term cone of depression that would extend up to approximately 7 miles northwest and 11 miles south-southeast from the center of the Betze-Post Pit. After hydraulic steady-state is reached, net evaporation would result in a net loss of approximately 2,700 acre-feet/year. This resultant loss of ground water through evaporation would persist into the future and represents an irreversible commitment of water resources.

# 3.3 Riparian Vegetation

## 3.3.1 Affected Environment

### 3.3.1.1 Study Area for Mine Dewatering and Localized Water Management Activities

The study area for riparian vegetation comprises of the hydrologic study area described in Section 3.2.1, Water Resources and Geochemistry, Affected Environment. Perennial creeks within the study area typically support a riparian zone ranging in width from a few feet immediately adjacent to the creek channel to relatively wide zones on broad floodplains. Riparian areas are valuable in providing sediment retention, nutrient removal and transformation, increased production (relative to uplands) for livestock and wildlife forage, habitat diversity for aquatic and terrestrial wildlife, and streambank stability.

Two riparian habitat inventories have been conducted in the study area (Whitehorse Associates 1995a, b; JBR 1993). Riparian habitat described in JBR (1993) also was provided in the SOAP EIS (BLM 1993b). Figure 3.3-1 illustrates riparian habitat within the study area and the riparian habitat identified during these inventories. Riparian inventories have not been conducted in the northeastern portion of the study area, which includes upper Susie Creek and associated tributaries. Perennial stream reaches in the study area also are illustrated in Figure 3.2-9. Table 3.3-1 lists the types and acres of riparian/wetland vegetation located in the study area by watershed and creek within each watershed. The inventory reports completed by Whitehorse Associates (1995a, b) and JBR (1993) included other riparian vegetation types in addition to those illustrated in Figure 3.3-1. The riparian vegetation illustrated in Figure 3.3-1 and the types and dominant species provided in this discussion only include the riparian vegetation types that supported a prevalence of wetland species and were associated with perennial or ephemeral creeks or wetlands. Approximately 4,337 acres of riparian/wetland habitat occur within the study area, of which 2,025, 1,685, 228, 388, and 10 acres are associated with the Maggie Creek, Rock Creek (including Boulder Flat), Susie Creek, Humboldt River watersheds, and small tributaries to the Humboldt River, respectively.

Table 3.3-2 lists the riparian/wetland vegetation types present within the study area and the dominant species associated with each type. Eight riparian vegetation types are present including streambar, herbaceous streambar, wet meadow, Salix (willow) streambar, Salix/wet meadow, Salix/mesic meadow, Salix/mesic meadow, and ALNINC (speckled alder)/mesic meadow. These types were developed and used during the 1994 riparian habitat inventory conducted by Whitehorse Associates within the Rock and Maggie Creek basins (Whitehorse 1995a, b). Riparian vegetation types and dominant species identified by JBR in the Maggie and lower Susie Creek basins were correlated with appropriate vegetation types identified by Whitehorse Associates. Results from these inventories indicate that the streambar riparian vegetation comprises approximately 42 percent (1,812 acres) of the riparian vegetation present within the study area. Other prevalent types include wet meadow (854 acres), Salix streambar (331 acres), Salexi/wet meadow (376 acres), and ALNINC/mesic meadow (248 acres).

Approximately 621 of the 4,337 acres of riparian vegetation that occur within the study area are within or adjacent to the predicted ground water drawdown area associated with the Goldstrike Mine (Figure 3.3-1). Herbaceous streambar riparian vegetation comprises approximately 61 percent (381 acres) of the 621 acres that occur within this area. Other prevalent types include ALNINC/mesic meadow (124 acres), streambar (44 acres), wet meadow (37 acres), and Salix streambar (32 acres). An additional 3 acres of riparian vegetation is associated with Salix/mesic meadow and Salexi/wet meadow riparian habitat types. Riparian habitat types and acres present within and adjacent to the predicted drawdown area are presented in bold type in Table 3.3-1.

The condition of riparian habitats in the Rock Creek and Maggie Creek basins was evaluated by Whitehorse Associates during the 1994 field season (Whitehorse Associates 1995a, b). Five riparian condition classes were developed by Whitehorse Associates, which included very poor (<50 percent), poor (50 to 60 percent), fair (61 to

## Table 3.3-1
## Acres of Riparian and Wetland Vegetation in the Study Area

| Watershed (*Stream*) | Area[1] | Streambar | Herbaceous Streambar | Wet Meadow | Salix Streambar | Salix/Wet Meadow | Salix/Mesic Meadow | Salexi/ Wet Meadow | ALNINC/Mesic Meadow | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Maggie Creek** | | | | | | | | | | |
| *Beaver Creek* | M1 | 2 | 1 | 1 | 0 | 0 | 0 | 1 | 47 | 52 |
| *Beaver Creek* | M2 | 121 | 6 | 3 | 22 | 0 | 42 | 0 | 77 | 271 |
| ***Coyote Creek*** | **M3** | **0** | **2** | **0** | **22** | **0** | **0** | **1** | **64** | **89** |
| *Coyote/Spring Creeks*[2] | M4 | 87 | 10 | 99 | 1 | 1 | 3 | 24 | 0 | 225 |
| ***Little Jack Creek*** | **M5** | **41** | **23** | **1** | **9** | **0** | **0** | **0** | **51** | **125** |
| *Little Jack and Jack*[3] *Creeks* | M6 | 31 | 32 | 128 | 13 | 0 | 1 | 37 | 0 | 242 |
| *Maggie Creek* | -- | 125 | 176 | 464 | 0 | 0 | 0 | 163 | 0 | 928 |
| *James Creek* | -- | 1 | 6 | 0 | 0 | 0 | 0 | 2 | 0 | 9 |
| *Soap Creek* | -- | 0 | 3 | <1 | 0 | 0 | 0 | 0 | 0 | 3 |
| *Marys Creek* | -- | 2 | 12 | <1 | 0 | 0 | 0 | 3 | 0 | 17 |
| *Mack Creek* | -- | 0 | 7 | 0 | 0 | 0 | 0 | 1 | 0 | 8 |
| ***Lynn/Simon Creeks*** | **--** | **0** | **2** | **29** | **0** | **0** | **0** | **0** | **0** | **31** |
| ***Cottonwood Creek*** | **--** | **3** | **4** | **0** | **0** | **0** | **0** | **0** | **0** | **7** |
| *E. Cottonwood Creek* | -- | 0 | <1 | 6 | 0 | 0 | 0 | 0 | 0 | 6 |
| *Fish Creek* | -- | 5 | 3 | 0 | 0 | 0 | 0 | <1 | 0 | 8 |
| *Indian Creek* | -- | <1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Bob's Creek* | -- | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| ***Subtotal*** | -- | *418* | *290* | *732* | *67* | *1* | *46* | *232* | *239* | *2,025*[4] |
| **Rock Creek** | | | | | | | | | | |
| *Rock Creek*[5] | R1 | 8 | 90 | 0 | 0 | 0 | 0 | 0 | 0 | 98 |
| *Rock Creek*[5] | R2 | 23 | 78 | 0 | 0 | 0 | 0 | 0 | 0 | 101 |
| *Rock Creek* | R3 | 29 | 171 | 0 | 0 | 0 | 0 | 0 | 0 | 200 |
| *Rock Creek* | R4 | 0 | 74 | 0 | 0 | 0 | 0 | 0 | 0 | 74 |
| *Willow Creek* | R5 | 0 | 107 | 80 | 12 | 0 | 0 | 139 | 0 | 338 |
| *Willow Creek* | R6 | 0 | 102 | 1 | 2 | 0 | 0 | 0 | 0 | 105 |
| *Willow Creek* | R7 | 20 | 69 | 7 | 1 | 0 | 0 | 3 | 0 | 99 |
| *Willow Creek* | R8 | 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 6 |
| *Willow Creek* | R9 | 0 | 70 | 7 | 0 | 0 | 2 | 1 | 0 | 80 |
| *Willow Creek* | R10 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| *Willow Creek* | R11 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | <1 | 3 |
| *Antelope Creek* | R12 | 0 | 48 | 0 | 0 | 0 | 0 | 0 | 0 | 48 |
| *Antelope Creek* | R13 | 0 | 67 | 0 | 0 | 0 | 0 | 0 | 0 | 67 |
| ***Antelope Creek*** | **R14** | **0** | 75 | **0** | **0** | **0** | **0** | **0** | **0** | 75 |

## Table 3.3-1 (Continued)
## Acres of Riparian and Wetland Vegetation in the Study Area

| Watershed (*Stream*) | Area[1] | Streambar | Herbaceous Streambar | Wet Meadow | Salix Streambar | Salix/Wet Meadow | Salix/Mesic Meadow | Salexi/ Wet Meadow | ALNINC/Mesic Meadow | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| ***Antelope Creek*** | **R15** | **0** | **98** | **5** | **0** | **0** | **0** | **0** | **0** | **103** |
| *Antelope Creek* | R16 | 0 | 47 | 11 | 1 | 1 | 5 | 0 | 0 | 65 |
| *Antelope Creek* | R17 | 0 | 7 | 0 | 1 | 0 | 20 | 0 | 0 | 28 |
| ***Boulder Creek*** | **R18** | **0** | **118** | **1** | **0** | **0** | **0** | **0** | **0** | **119** |
| ***Boulder Creek*** | **R19** | **0** | **35** | **0** | **1** | **0** | **1** | **0** | **9** | **46** |
| *Green, Knob, and Sand Dune Springs*[6] | R20 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ***Green, Knob, and Sand Dune Springs***[6] | **R21** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| ***Welches Creek*** | **R22** | **0** | **24** | **1** | **0** | **0** | **1** | **0** | **0** | **26** |
| ***Subtotal*** | -- | *80* | *1,288* | *116* | *18* | *1* | *30* | *144* | *9* | *1,685*[4] |
| **Susie Creek** | | | | | | | | | | |
| *Cold Creek*[7] | -- | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| *Blue Basin Creek*[7] | -- | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| *Adobe Creek*[8] | -- | 1 | <1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Swales Creek*[7] | -- | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| *Camp Creek*[7] | -- | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| *Susie Creek*[2] | -- | 127 | 77 | 0 | 0 | 0 | 0 | 0 | 0 | 204 |
| *Middle Susie Creek*[7] | -- | 0 | <1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Hot Springs Drainage* | -- | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| ***Subtotal*** | -- | *140* | *87* | *1* | *0* | *0* | *0* | *0* | *0* | *228*[4] |
| **Humboldt River Tributaries** | | | | | | | | | | |
| *Primeaux Creek* | -- | <1 | <1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| *Palisade Creek* | -- | 0 | <1 | 0 | 0 | 0 | 0 | 0 | 0 | <1 |
| *Buck Rake Jack Creek* | -- | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| *Dry Susie Creek* | -- | 0 | <1 | 0 | 4 | 0 | 0 | 0 | 0 | 4 |
| *Subtotal* | -- | *0* | *6* | *0* | *4* | *0* | *0* | *0* | *0* | *10*[4] |
| **Humboldt River** | -- | 0 | 141 | 5 | 242 | 0 | <1 | 0 | 0 | 388 |
| ***Subtotal*** | -- | *0* | *141* | *5* | *242* | *0* | *0* | *0* | *0* | *388*[4] |
| ***Total*** | -- | *638* | *1,812* | *854* | *331* | *2* | *76* | *376* | *248* | *4,337*[4] |

Sources: Whitehorse Associates 1995a, b; BLM 1993b; JBR 1993.

Note: **BOLD** type indicates the riparian inventory areas that are within the 10-foot ground water drawdown area predicted for the Goldstrike Mine.

[1] Inventory areas used by Whitehorse Associates 1995a, b.

## Table 3.3-1 (Continued)
## Acres of Riparian and Wetland Vegetation in the Study Area

[2] Riparian acreage for the lower portion of Susie Creek was based on acreages reported in BLM 1993b. Riparian acreage for the upper portion of Susie Creek was based on the assumption stated in footnote 7. Riparian acreage estimates may be low since riparian habitat along upper Susie Creek has not been inventoried, and the area does support several, large wet meadow complexes.

[3] Acreage was based on Whitehorse Associates 1995b; BLM 1993b.

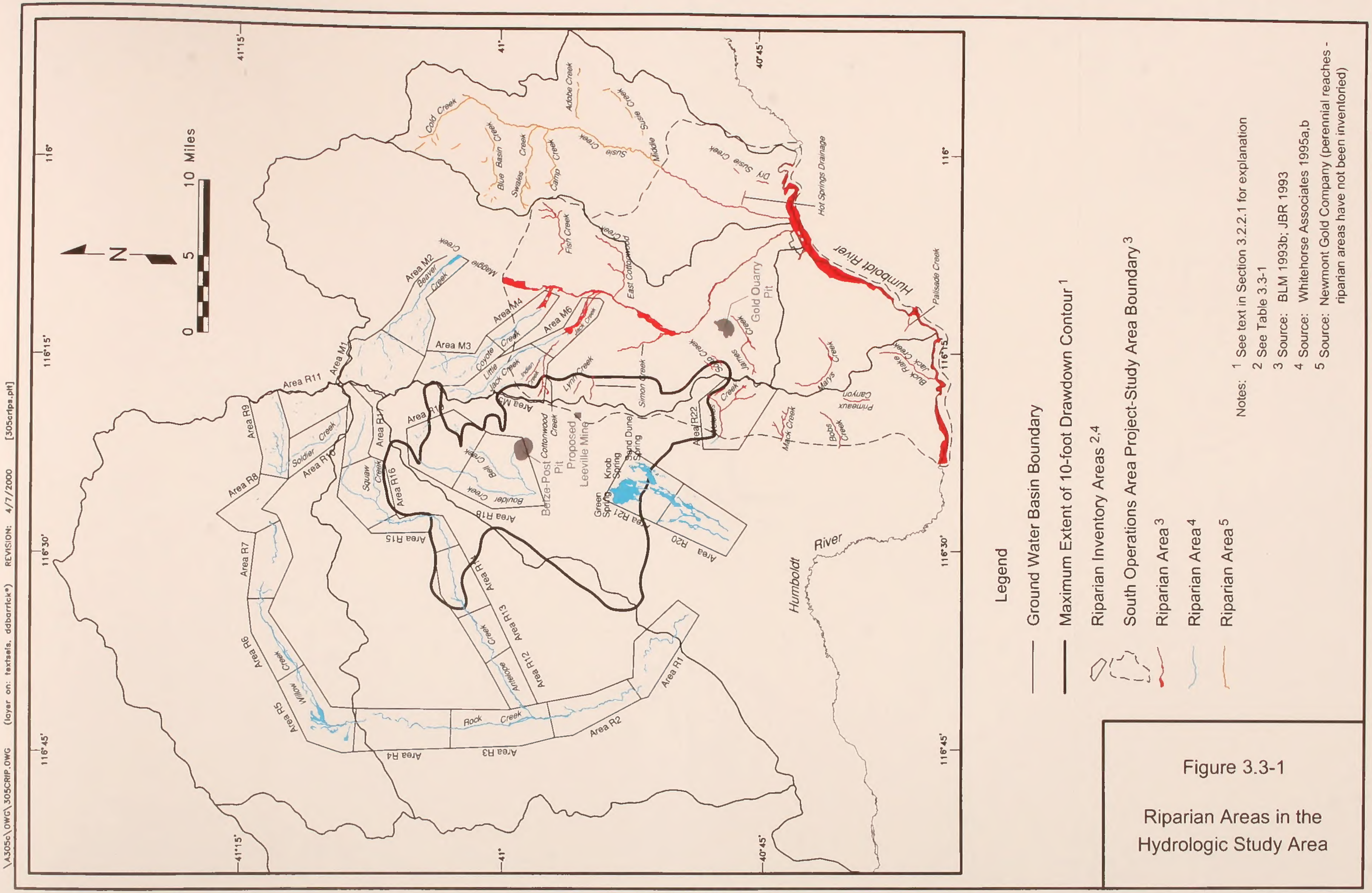
[4] Numbers are approximate due to rounding.

[5] Rock Creek could be affected since existing monitoring wells are exhibiting drawdown.

[6] An additional 2,819 acres of Marsh/Transition to Marsh riparian vegetation was identified in R20 and R21 that was associated with the newly formed springs in Boulder Valley. The dominant species present was *Typha latifolia* (cattail).

[7] An average width of 5 feet was assumed for riparian vegetation along these creeks since riparian inventories have not been conducted.

[8] Riparian vegetation associated with this creek has an average width of 35 feet.



Notes: [1] See text in Section 3.2.2.1 for explanation
[2] See Table 3.3-1
[3] Source: BLM 1993b; JBR 1993
[4] Source: Whitehorse Associates 1995a,b
[5] Source: Newmont Gold Company (perennial reaches - riparian areas have not been inventoried)

Figure 3.3-1

Riparian Areas in the Hydrologic Study Area

## Table 3.3-2
## Wetland and Riparian Vegetation Types and Dominant Species in the Study Area

| Vegetation Type | Site | Dominant Species[1] |
|---|---|---|
| Streambar | Above streamside type on stream deposits below ordinary high water mark (OHWM) | Annual muhly (*Muhlenbergia minutissima*), rabbitfootgrass (*Polypogon monspeliensis*), American bulrush (*Scirpus americanus*), coyote willow (*Salix exigua*), silverweed cinquefoil (*Potentilla anserina*), exalted centaury (*Centaurian exaltatum*), Canada horseweed (*Conyza canadensis*) |
| Herbaceous Streambar[2] | In or immediately adjacent to streams at or below OHWM or within channel or adjacent to stream below OHWM; in low lying oxbows, meanders, and sloughs with standing water or high groundwater throughout or late into the growing season; older relatively, dry meanders and upland terraces. | Fewflowered spikerush (*Eleocharis pauciflora*), American bulrush (*Scirpus americanus*), annual muhly (*Muhlenbergia minutissima*), American speedwell (*Veronica americana*), Kentucky bluegrass (*Poa pratensis*), Baltic rush ( *Juncus balticus*), povertyweed (*Iva axillaris*), rabbitfootgrass (*Polypogon monspeliensis*), Canada cocklebur (*Xanthium strumarium*), inland saltgrass (*Distichlis spicata*), fivehook bassia (*Bassia hyssopifolia*), whitetop (*Cardaria draba*), black greasewood (*Sarcobatus vermiculatus*), reed canarygrass (*Phalaris arundinacea*), seepweed (*Suaeda* spp.) |
| Wet Meadow[3] | Within perennial streams or artesian seeps and springs in broad floodplains; ponds formed in deeper oxbows, meanders, borrow pits, or other depressions. | Cattail (*Typha latifolia*), hardstem bulrush (*Scirpus acutus*), American bulrush (*Scirpus americanus*), Nebraska sedge (*Carex nebraskensis*), Baltic rush (*Scirpus balticus*), woolly sedge (*Carex lanuginosa*), fowl bluegrass (*Poa palustris*), western mountain aster (*Aster occidentalis*), annual muhly (*Muhlenbergia minutissima*), slim sedge (*Carex praegracilis*), redtop bentgrass (*Agrostis stolonifera*), common yarrow (*Achillea millefolium*), Kentucky bluegrass (*Poa pratensis*), silverweed cinquefoil (*Potentilla anserina*), potentilla (*Potentilla gracilis*), and submerged or floating aquatics in open water |
| Salix Streambar[4] | Seasonally flooded levees and channels; recently exposed stream-laid deposits, moist to wet soils lining channel banks, newer oxbows and meanders; older stream-laid deposits and older oxbows and meanders and irrigation ditches. | Coyote willow (*Salix exigua*), cheatgrass (*Bromus tectorum*), false yarrow (*Chaenactis douglasii*), hairy willow-herb (*Epilobium cilitatum*), Scotch cotton-thistle (*Onopardum acanthium*), ragweed (*Ambrosis* spp.), rabbitfootgrass (*Polypogon monspeliensis*), Woods rose (*Rosa woodsii*), reed canarygrass (*Phalaris arundinacea*), common reed (*Phragmites australis*), and white sweetclover (*Melilotus alba*) |
| Salix/Wet Meadow | Seasonally flooded, saturated, or semipermantly flooded wetland | Pacific willow (*Salix lasiandra*), American mannagrass (*Glyceria grandis*), marsh yellow-cress (*Rorripa islandica*) |
| Salix/Mesic Meadow[5,8] | Banks adjacent to streams or in areas of high water table; moist, subirrigated low areas. | Yellow willow (*Salix lutea*), Kentucky bluegrass (*Poa pratensis*), Douglas sedge (*Carex douglasii*), western mountain aster (*Aster occidentalis*), coyote willow (*Salix exigua*), catchweed bedstraw (*Galium aparine*), Canada thistle (*Cirsium arvense*), fewflowered spikerush (*Eleocharis pauciflora*), creeping wildrye (*Elymus tritichoides*), common yarrow (*Achillea millefolium*), annual muhly (*Muhlenbergia minutissima*), fowl bluegrass (*Poa palustris*), narrowleaf cottonwood (*Populus angustifolia*), black cottonwood (*Populus balsamifera trichocarpa*), and Popular (*Populus* spp.) |

## Table 3.3-2 (Continued)
## Wetland and Riparian Vegetation Types and Dominant Species in the Study Area

| Vegetation Type | Site | Dominant Species[1] |
|---|---|---|
| Salexi/Mesic Meadow | Intermittently or seasonally flooded channels and levees | Coyote willow (*Salix exigua*), Nebraska sedge (*Carex nebraskensis*), Kentucky bluegrass (*Poa pratensis*), water groundsel (*Senecio hydrophilus*), field mint (*Mentha arvense*) |
| ALNINC/Mesic Meadow | Seasonally flooded wetland | Pacific willow (*Salix lasiandra*), Booth's willow (*Salix boothii*), slender hairgrass (*Deschampsia elongata*), Kentucky bluegrass (*Poa pratensis*), stinging nettle (*Urtica dioca*), curly dock (*Rumex crispus*), Oregon checker-mallow (*Sidalcea oregana*) |

[1] Sources: Whitehorse Associates 1995a, b; BLM 1993b.

[2] Includes Gravel Bar and Bulrush/Cattail and saltgrass vegetation types as described in BLM 1993b.

[3] Includes Cattail/Pond, Sedge Meadow, Baltic Rush Meadow, and Grassy Wet Meadow/Grassy Meadow and Open Water vegetation types as described in BLM 1993b.

[4] Includes Yellow Willow and Coyote Willow thicket and poplar vegetation types as described in BLM 1993b.

[5] Includes Young and Mature Willow as described in BLM 1993b.

80 percent), good (81 to 90 percent), and excellent (91 to 100 percent). Riparian condition was based on channel morphology, which directly affects hydrologic attributes and associated riparian vegetation types. Riparian habitat inventories and the identified conditions for specific streams within these basins are described in the following sections.

## Maggie Creek Watershed

Riparian habitat inventories were conducted along Beaver, Coyote, Little Jack, and Jack creeks by Whitehorse Associates in 1995 and along Spring, Jack, lower Maggie, James, Soap, Marys, Lynn/Simon, Bobs, Mack, Cottonwood, East Cottonwood, Fish, and Indian creeks by JBR in 1993 (Whitehorse Associates 1995a, b; JBR 1993). Approximately 46 percent (928 acres) of the riparian habitat present within the watershed occurs along Maggie Creek. Other creeks within the watershed that support substantial riparian habitat include Beaver Creek (323 acres), Coyote/Spring Creeks (314 acres), and Little Jack/Jack Creeks (367 acres). Wet meadow is the predominant riparian vegetation type within this watershed. The average riparian condition within this watershed was classified as poor (53 percent) (Whitehorse Associates 1995a, b). Riparian habitat conditions associated with Beaver (58 percent), Coyote (53 percent), and Jack creeks (50 percent) was classified as poor.

As part of the Mitigation Plan for the development of the SOAP, Newmont Gold Company, in conjunction with the Elko BLM and Elko Land and Livestock Company, developed the MCWRP to improve streams, riparian habitats, and watershed conditions within the Maggie Creek subbasin (BLM 1993b). The MCWRP was designed to enhance 1,982 acres of riparian habitat, over 40,000 acres of upland watershed, and 82 miles of stream channel within the Maggie Creek subbasin (BLM 1993b). Components of the plan included exclosure and pasture fencing for livestock grazing management, conservation easements, water developments, water augmentation, riparian plantings, and other measures. Restoration of Lahontan cutthroat trout (LCT) habitat was a key consideration in development of the plan.

The MCWRP includes the management and monitoring of stream and riparian habitats associated with Maggie, Coyote, Indian Jack, Little Jack, Lynn, and Simon creeks. An additional 23 spring sites also were fenced and developed where possible to provide alternate sources of water for livestock. Streams and associated riparian habitats are included within 16 pastures (see Figure 3.7-3 in Section 3.7). Changes in grazing management on these areas has included total exclusion of livestock; exclusion of livestock until selected biological standards have been met followed by limited, prescription grazing; and application of various grazing systems. Additional pastures controlled by Maggie Creek Ranch were initially identified for improvement in the MCWRP; however, no changes in management of these areas is known to have occurred.

Since the MCWRP was implemented in 1993, improvement of riparian habitat including streams occupied by LCT has been excellent (BLM 1997a, 1999). Streams that were once characterized by eroding streambanks and a wide, shallow channel profile now support healthy functioning riparian zones and stable, well vegetated streambanks. Where biological criteria have been established for the reintroduction of grazing, standards have been met, and grazing has been applied on a prescription basis since 1997.

## Rock Creek Watershed

Riparian habitat inventories were conducted along Rock, Willow, Antelope, Boulder, and Welches creeks by Whitehorse Associates in 1995 (Whitehorse Associates 1995a, b). In addition, riparian/wetland habitats associated with Green, Knob, and Sand Dune springs located in Boulder Valley also were delineated. Approximately 89 percent (1,494 acres) of the riparian vegetation present within this watershed was observed along Rock (473 acres), Willow (635 acres), and Antelope creeks (386 acres). Herbaceous streambar is the predominant riparian vegetation type that occurs in this watershed. The average riparian condition within this watershed was classified as very poor (48 percent). Riparian habitat conditions associated with Antelope (35 percent), Boulder (29 percent), Rock (47 percent), Welches (46 percent), and

Willow creeks (69 percent) were classified as very poor to fair (Whitehorse Associates 1995a, b).

Riparian surveys also were conducted in numerous Rock Creek tributaries in 1994 and 1997 (BLM 1998c). The surveys indicated that riparian condition class was excellent in Frazer Creek within the BLM exclosures; fair in Frazer Creek below the BLM exclosures, upper Toe Jam Creek, and upper Rock Creek; and poor in lower Toe Jam Creek and upper Willow Creek. The condition class was based on the percent of bank cover and stability. The percent bank cover ranged from 42 to 50 percent of optimum growth for Toe Jam, Frazer (below BLM exclosures), upper Rock, and upper Willow creeks. Riparian bank cover in the Frazer Creek BLM exclosure area was 90 percent of optimum.

### Susie Creek Watershed

Riparian habitat inventories were conducted along lower Susie Creek and the Hot Springs drainage by JBR in 1993 (JBR 1993). Figure 3.3-1 illustrates the perennial stream reaches that have not been inventoried, including the upper portion of Susie Creek and associated tributaries. Susie Creek supports approximately 89 percent (204 acres) of the riparian habitat observed within the watershed. Streambar is the predominant riparian vegetation type that occurs in this watershed. The condition of riparian habitat within this watershed is considered good to excellent in over 9 miles of the lower reaches. Riparian quality is considered degraded on private lands located upstream.

### Small Tributaries to the Humboldt River

Riparian habitat inventories along small tributaries to the Humboldt River (i.e., Primeaux, Palisade, Buck Rake Jack, and Dry Susie creeks) were conducted by JBR in 1993 (JBR 1993; BLM 1993b). Approximately 5 and 4 acres of riparian habitat were observed along Buck Rake Jack and Dry Susie creeks, respectively. Primeaux and Palisade creeks support approximately 2 acres of riparian vegetation. Herbaceous streambar is the predominant riparian vegetation type that occurs in this area. The condition of riparian habitat within this area is unknown.

### Humboldt River

A riparian habitat inventory was conducted along the Humboldt River by JBR in 1993 (JBR 1993; BLM 1993b). Approximately 388 acres of riparian vegetation were observed along the Humboldt River. Salix streambar is the predominant riparian vegetation type (242 acres) that occurs along the Humboldt River. The condition of riparian habitat is unknown.

Based on a series of field investigations, all springs and seeps identified in the study area are illustrated in Figure 3.2-9 (JBR 1990a; RTi 1994; JBR 1992b; Newmont 1999c). These springs and seeps are primarily associated with perennial streams in the study area and support wetland species commonly associated with riparian areas.

### Goldstrike Mine Area

Representative seeps and springs also have been sampled for a number of years in the Goldstrike Mine vicinity to determine whether or not dewatering activities are affecting flows. As part of the monitoring effort, vegetation transects were established in 1993 at several of the sampling sites to assess annual variations in the vegetative structure and species composition of the springs and seeps within the project area (Keammerer 1998). Eight transects at spring, seep, and creek bottom sites located east and west of the Betze Pit have been sampled annually since 1993, and eight additional transects were established in 1995 north and west of the Betze Pit. Table 3.3-3 lists the types of dominant vegetation associated with each transect and notes regarding grazing impacts on existing vegetation. The optimum areas for evaluating potential effects are transects located in seep areas that are not grazed (Keammerer 1997). In 1993, 66 species were observed, compared with 77 species in 1997 and 1998 (Keammerer 1998). Differences in overall species composition have been minor and are most likely not related to mining activities, but rather to grazing intensity, yearly precipitation variations, and differences related to field observations (Keammerer 1998). At most sites, no changes related to dewatering have been observed over the 5-year sampling period; one exception is a site on Brush Creek where flows and vegetation have been affected by dewatering activities.

### Table 3.3-3
### Vegetation Associated with Seeps and Springs

| **Dominant Plant Species in Vegetation Transects Sampled Since 1993** | **Documented Grazing Influences** |
|---|---|
| Cocklebur (*Xanthium strumarium)*, cheatgrass (*Bromus tectorum)* | None noted |
| Alkali bluegrass (*Poa juncifolia*), alkali cordgrass (*Spartina gracilis*), alkali muhly (*Muhlenbergia asperifolia)* | None noted |
| Red top (*Agrostis alba)*, Kentucky bluegrass (*Poa pratensis),* Nebraska sedge (*Carex nebraskensis*), common spikerush (*Eleocharis* sp.), | Grazed previously[1] |
| Three-stamen rush (*Juncus ensifolius)*, Nebraska sedge | Ungrazed until 1998 |
| Kentucky bluegrass, dandelion (*Taraxacum officinale)*, red top | Heavily grazed[1] |
| Meadow barley (*Hordeum brachyantherum*), bacopa (*Bacopa rotundifolia)*, Kentucky bluegrass | Heavily grazed[1] |
| Red top, bacopa | Grazed[1] |
| Meadow barley | Grazed[1] |
| **Dominant Plant Species in Vegetation Transects Sampled Since 1995** | |
| Chairmaker's rush (*Scirpus americanus)*, alkali muhly, scouring rush | Ungrazed |
| Chairmaker's rush, strawberry clover (*Trifolium fragiferum*) horsetail (*Equisetum laevigatum)* | Heavily grazed[1] |
| Baltic rush, dandelion | Grazed[1] |
| Chairmaker's rush, Baltic rush | Grazed in some years[1] |
| Nebraska sedge | Heavily grazed[1] |
| Sedge (*Carex* spp.), common spikerush, Nebraska sedge | Grazed |
| Baltic rush, common spikerush | Grazed |
| Mat muhly (*Muhlenbergia richardsonis)*, red top, Kentucky bluegrass | Grazed[1] |

Source: Keammerer 1998, as appended to Adrian Brown Consultants, Inc. 1998.
[1] Year-to-year differences in vegetative cover are likely related to cattle grazing.

Following the appearance of the three springs (i.e., Green, Knob, and Sand Dune springs) in Boulder Valley, wetland vegetation developed in the areas of standing water (see areas R20 and R21 in Figure 3.3-1). In 1995, the Sand Dune drainage area included approximately 885 acres of riparian vegetation primarily consisting of cattails (*Typha latifolia*) and 80 acres of desert saltgrass (*Distichlis stricta*) (Woodward-Clyde 1996). At the time of the study, approximately 1,935 acres were covered with standing water. This area was described as 2,819 acres of Marsh and Transition to Marsh vegetation in the Whitehorse study (Whitehorse Associates 1995a, b). The mounding of water in upper Boulder Valley is predicted to gradually subside and dissipate. As water levels subside, the wetland vegetation would decline and likely be replaced by uplands dominated by salt-tolerant species.

#### 3.3.1.2 Humboldt River Study Area

Riparian habitat associated with the Humboldt River supports various riparian vegetation types including willow, cottonwood, bulrush, cattail, saltgrass, and stream deposits (Rawlings and Neel 1989). The majority of riparian vegetation occurs in areas with numerous meanders and oxbows. The riparian habitat survey conducted by Rawlings and Neel (1989) included the Humboldt River and its major tributaries from the Deeth area (approximately 32 miles northeast of Elko) to Rye Patch Reservoir (204 miles). The 53-mile portion of the river that extends from the Dunphy discharge point to the Comus gaging station supports approximately 8,618 acres of riparian vegetation and includes:

- Willow – 2,311 acres;
- Cottonwood – 16 acres;
- Bulrush – 2,810 acres;
- Cattail – 330 acres;
- Saltgrass – 2,410 acres; and
- Stream deposits – 741 acres.

Willow stands typically occur in recent to old stream-laid deposits, moist to wet soils lining channels, oxbows, meanders, and irrigation ditches. This vegetation type is characterized by a dominant shrub layer consisting of coyote willow and Wood's rose and a subdominant layer of herbaceous species dominated by rabbitsfoot-grass (*Polypogon monspeliensis*), reed canary-grass (*Phalaris arundinacea*), common reed (*Phragmites australis*), cheatgrass (*Bromus tectorum*), and ragweed species (*Ambrosia* sp.). Some of the willow stands include minor populations of tamarisk (*Tamarix ramosissima*), which is considered an invader species. Cottonwood stands are associated with moist, subirrigated low areas that are dominated by narrowleaf cottonwood (*Populus angustifolia*) and black cottonwood (*Populus trichocarpa*) trees and an understory consisting of upland herbaceous species.

Bulrush communities are established in low-lying oxbows, meanders, and sloughs with high ground water late into the growing season. Plant species commonly associated with this vegetation type include various bulrushes, rushes, and sedges. Cattail communities also occur in low-lying oxbows, and meanders and sloughs with standing water or high ground water throughout the growing season. Species that are commonly associated with these communities include common cattail, bulrushes, and rushes. Saltgrass communities are established on older, relatively dry meanders and upland terraces and typically support inland saltgrass, black greasewood (*Sarcobatus vermiculatus*), reed canary-grass, and seepweed (*Suaeda* sp.).

Stream deposits occur along seasonally exposed stream-laid deposits within or adjacent to active channels. These areas are typically devoid of vegetation or sparsely vegetated with annual weed species or young willows.

The Nevada Division of Wildlife (NDOW) conducted riparian habitat studies at eight sites along this segment of the Humboldt River (Bradley and Neel 1990; Bradley 1992; and Neel 1994). The condition of these sites ranged from poor to excellent including three sites in poor condition; two sites in fair or fair to good condition; two sites in good condition; and one site in excellent condition. Riparian areas in poor condition were characterized by low plant cover, especially willows, and typically support minimal riparian vegetation resulting from flooding or overgrazing. The site in excellent condition was characterized by above average plant cover provided by willows and was located in the Herrin Slough area.

The Humboldt River extends approximately 141 miles from the Comus gaging station to the Humboldt Sink; 21 miles of the river is impounded to form Rye Patch Reservoir. The upper segment of the river extends approximately 71 miles from the Comus gaging station to Rye Patch Reservoir, and the lower segment extends approximately 49 miles from the Rye Patch Reservoir Dam to the Humboldt and Carson sinks.

Riparian habitat studies were conducted by NDOW at eight sites along the segment of the Humboldt River extending from the Comus gaging station to Rye Patch Reservoir (Neel 1994). The condition of these sites ranged from poor to good including one site in poor condition and seven sites in good condition. Poor condition in the riparian area was characterized by low plant cover; especially by willows, and supported minimal riparian vegetation resulting from flooding or overgrazing. The seven sites in good condition were characterized by extensive willow and bulrush communities associated with meanders and oxbows.

Based on riparian habitat studies conducted by the NDOW, a net loss of 13.4 miles of river length between Dunphy and Rye Patch Reservoir has occurred during the past 30 years. Substantial loss of river length and sinuosity has occurred in the Dunphy and Argenta area, and downstream to Winnemucca. In other locations, such as near Comus and Winnemucca, the river has both increased and decreased its length.

Prior to the 1950s, a large wetland complex named the Big Slough existed along the Humboldt River approximately halfway between Battle Mountain and Dunphy. This complex consisted of wetlands and abandoned channels that supported extensive stands of willow and other riparian and wetland vegetation. During the 1950s, this area was drained by a Federal channelization project, which straightened the course of the river for several miles through the Argenta vicinity and elsewhere along the river. This area is currently referred to as the former Argenta Marsh and primarily supports upland species. NDOW and other public and private organizations are interested in restoration of the former Argenta Marsh with the use of mine discharge water in the river (see Section 3.2.1.3). The majority of the riparian/wetland vegetation associated with Rye Patch Reservoir is located where the river enters the reservoir. Riparian plant species established in this area primarily include willows and tamarisks. Riparian vegetation is limited along the remainder of the reservoir shoreline due to the deep water near the shoreline, fluctuating water levels, and steep banks. Narrow bands of riparian vegetation, primarily consisting of willows, are established along the shorelines of Upper and Lower Pitt-Taylor reservoirs.

The segment of the Humboldt River extending from Rye Patch Reservoir to the Humboldt Sink is characterized by a well-defined, deeply incised river channel with low channel sinuosity, which supports narrow, localized bands of riparian vegetation established along the river bank or sandbars. The river channel and the associated extent of riparian vegetation within the floodplain in the Lovelock area is narrower as a result of various water diversions.

Prior to agricultural development in the region, most of the water of the Humboldt River flowed unrestricted to the Humboldt Sink wetlands. At the end of the 19th century the Humboldt Sink supported approximately 58,000 acres of wetland vegetation (Seiler et al. 1993). Wetlands were extensive, and the lower valley was a large meadow (Big Meadow). The most common plants in the wetlands included alkali bulrush (*Scripus paludosus*), cattails, sago pondweed (*Potamogeton pectinatus*), and muskgrass (*Chara* sp.). Dikes were built along the lower Humboldt River, and wetlands were drained for crops. The area formerly known as the Big Meadow became the Lower Valley agricultural area (Seiler et al. 1993). Between 1949 and 1973, wetlands within the Humboldt Wildlife Management Area (HWMA) covered only 12,850 acres, or 22 percent of its original size (Hallock et al. 1981).

Three wetlands units occur in the HWMA including the Upper Humboldt Lake, Lower Humboldt Lake, and Toulon Lake. Water depth in the Upper and Lower Humboldt lakes typically ranges from 2 to 18 inches; approximate water depth during the 1880s was estimated at 12 feet. Toulon Lake is approximately 4 feet higher than Humboldt Lake and is not directly fed by the Humboldt River. Prior to agricultural development in the Lovelock area, Toulon Lake was intermittently filled by spillover from the Humboldt Lakes (Seiler et al. 1993). During the 1930s and 1940s, prior to the completion of the Toulon Drain, Toulon Lake was an alkali playa.

The Carson Sink is an alkaline playa lake that supports limited wetland vegetation. The high salinity in the water makes it intolerable for most plants except salt-tolerant plants, including seepweed and desert saltgrass.

## 3.3.2 Environmental Consequences

### 3.3.2.1 Impacts from Mine Dewatering and Localized Water Management Activities

The potential for impacts to riparian areas is based on the (1) predicted ground water drawdown and (2) the connectivity of the perennial streams, seeps, and springs supporting riparian vegetation with the regional ground water aquifer (see Section 3.2.2.1, Impacts to Perennial Springs and Streams).

Ground water model simulations suggest that reductions in baseflow could occur in Antelope and Boulder creeks, and tributaries to Maggie Creek (see Section 3.2.2.1). However, because of the limitations inherent in hydrologic modeling and the uncertainty regarding the hydrologic interconnection between the streams and the regional ground water system, the actual extent and magnitude of impacts to riparian vegetation are uncertain.

Figure 3.3-2 illustrates the riparian areas that potentially could be affected by ground water drawdown associated with ground water pumping for Goldstrike Mine dewatering. The riparian areas within the shaded area in Figure 3.3-2 are located in areas where perennial waters potentially could be impacted by drawdown; therefore, the potential exists for impacts to some of the associated riparian areas. Other riparian vegetation areas within the 10-foot drawdown area are unlikely to be affected by ground water drawdown (see Section 3.2.2.1). Approximately 137 acres (22 percent) of the 621 acres of riparian vegetation within the predicted 10-foot drawdown area occur within the areas where perennial waters could be affected by ground water drawdown (see Figure 3.3-2). The remaining 484 acres of riparian vegetation occur outside of these areas and are considered less likely to be affected by ground water drawdown. The following sections provide specific information regarding riparian vegetation that potentially could be affected by ground water drawdown by individual watersheds.

Drawdown could reduce the baseflow of perennial creeks within the area. Exposed channel sediments during reduced baseflow periods would be prone to invasion by noxious weeds. Noxious weed species, including Scotch thistle, Canada thistle, leafy spurge, whitetop, water hemlock, diffuse knapweed, and Russian knapweed, could become established within these channels (BLM 2000a). Riparian vegetation would likely dominate these areas after water levels returned to premine conditions.

**Rock Creek Watershed**

Approximately 136 acres of riparian vegetation associated with Boulder, Bell, and Welches creeks could be affected by ground water drawdown associated with the Goldstrike Mine. The majority of the riparian vegetation (135 acres) that could be affected is associated with Boulder and Bell creeks; approximately 1 acre of riparian vegetation is associated with Welches creek. As stated in Section 3.2.2.1, ground water drawdown could extend to within 1 to 2 miles of perennial reaches located in the upper Antelope Creek watershed. In addition, some discontinuous stream segments (located downstream from the perennial reaches) are located within the projected drawdown area. Considering the uncertainty of the long-term drawdown predictions, future drawdown potentially could impact riparian vegetation along these stream segments. Riparian vegetation present along lower Rock Creek is located several miles outside of the predicted 10-foot drawdown area and is unlikely to be affected by drawdown (see Section 3.2.2.1).

**Maggie Creek Watershed**

One acre of riparian vegetation associated with Soap Creek could be affected by ground water drawdown associated with the Goldstrike Mine. Riparian vegetation (38 acres) associated with Cottonwood, Lynn, and Simons creeks is unlikely to be affected by ground water drawdown.

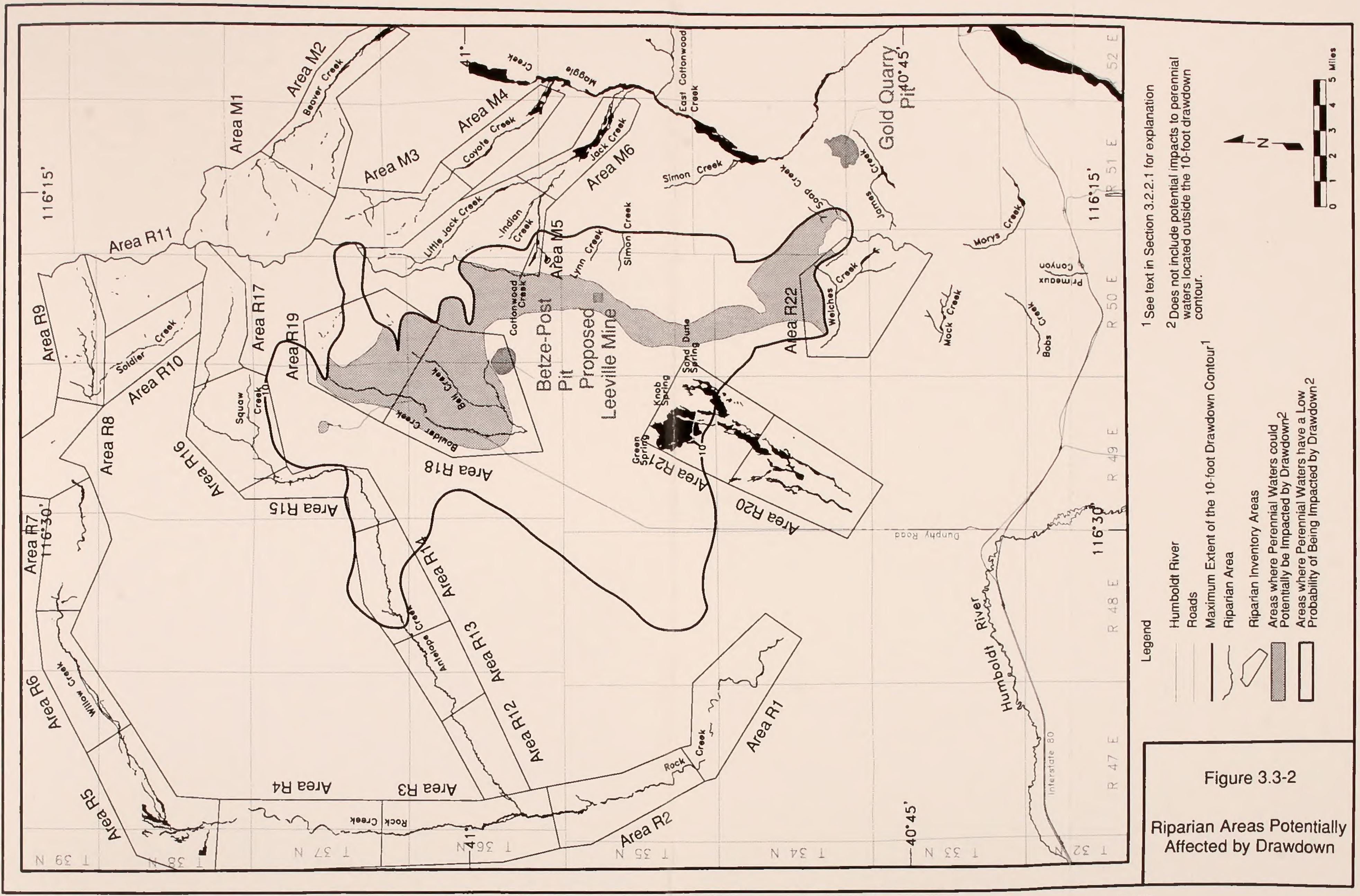
**Isolated Springs and Seeps**

Approximately 44 isolated springs and seeps, that are not associated with perennial stream reaches, occur within areas where perennial waters could be impacted by drawdown (see Figure 3.2-9). Based on the SOAPA Draft EIS (BLM 2000a) and the 1993 SOAP EIS (BLM 1993b), the majority of wetlands observed within the Maggie Creek basin range from 0.1 acre to 1.0 acre in size. Assuming that each spring supports an average of 0.3 acre of wetland vegetation, an estimated 13 acres of wetland vegetation occur within areas where perennial waters could be impacted.

In summary, according to ground water modeling and associated water resources analyses, approximately 137 acres of riparian vegetation associated with perennial stream reaches and 13 acres of wetland vegetation associated with isolated seeps and springs are located within areas where some reduction in flow could occur. Therefore, 150 acres of riparian/wetland vegetation within these areas potentially could be affected by ground water drawdown for the Goldstrike Mine.

### 3.3.2.2 Impacts to the Humboldt River

Natural fluctuations in water levels caused by seasonal variations and flood and drought events



[1] See text in Section 3.2.2.1 for explanation

[2] Does not include potential impacts to perennial waters located outside the 10-foot drawdown contour.

Figure 3.3-2

Riparian Areas Potentially Affected by Drawdown

greatly influence the distribution and extent of riparian vegetation established within the Humboldt River floodplain. As described in Section 3.2.2.2, Barrick's discharges would temporarily increase flows in the Humboldt River. Increased water levels potentially could affect channel configuration, depth, and sinuosity that directly affect the distribution and extent of riparian vegetation.

In general, the peak Humboldt River flow months (i.e., May and June) would not be affected by additional Goldstrike Mine discharge. Relative to the natural fluctuations in river flows during these months, the increases would be small and would have no impact to the flow regime of the Humboldt River during average peak flow months. Water discharges into the river could result in a minimal increase during low-flow periods. During low-flow periods (September to November), the average water depth could increase approximately 1.2 feet (0.8 to 1.6 feet), and channel width could increase approximately 38 feet under the maximum Goldstrike Mine discharge scenario.

Effects from increased water levels during baseflow periods include an increase in elevated water table in low-lying areas located adjacent to the river, increasing the frequency of flooding of stream meanders and oxbows. Riparian/wetland plants could become established in areas where the water table is elevated to the rooting depths needed for riparian/wetland plant establishment. Stream meanders and oxbows could be more frequently subjected to flood events, further enhancing the potential for riparian/wetland plant establishment. Increased baseflows and slightly increased peak flows could facilitate the establishment of willows along the main river channel and side channels since the water levels would be more constant throughout the year. Increases in the extent of riparian vegetation would be most noticeable along segments of the river with gradual banks and low-lying areas located adjacent to the river. These areas could be more frequently flooded during peak flows, and the water table could be shallow due to increased baseflows.

An additional effect resulting from increased water levels during low-flow periods would be the potential for restoring or enhancing specific wetland and marsh habitats in Herrin Slough. Riparian/wetland areas currently present in Herrin Slough, which consists of a series of low-gradient channels, could be enhanced by increased baseflows and slightly elevated peak flows. Water levels in Upper and Lower Pitt-Taylor Reservoirs could become more consistent, which would improve conditions for wetland and aquatic plant establishment.

Additional effects may include channel instability in the reach extending approximately 3 miles upstream and downstream from the Barrick outfall, deepening of the river channel, and loss of streamside riparian vegetation due to increased erosion and destabilization of stream banks.

Small, isolated stands of wetland vegetation that occur along the banks of Rye Patch Reservoir would likely be lost if water levels were consistently high within the reservoir during periods of high water discharge. As a result of consistently high water levels, wetland vegetation could be lost to inundation. Steep banks immediately adjacent to the reservoir would make it difficult for wetland vegetation to become re-established. Wetland vegetation would not become established until water levels were comparable to pre-discharge water levels.

Depending on irrigation withdrawals and returns during the period of discharges, the areal extent of wetland vegetation within the Humboldt Sink could increase as a result of higher and more consistent water levels. Consistent high water levels in the Humboldt Sink could flood and kill stands of salt cedar. Portions of the sink that were seasonally flooded would likely be perennially inundated, resulting in the temporary loss of emergent wetland vegetation until it becomes established along the margins of the sink. Dense stands of salt cedar could become re-established on exposed sediments during low-water periods. Increased water levels also would increase the extent of open water habitats that would facilitate aquatic plant establishment. These effects would subside when mine discharges cease. Excess water from the Humboldt Sink may occasionally reach the Carson Sink during high-water periods. The Carson Sink is a shallow, highly alkaline playa lake that primarily supports salt-tolerant upland species. However, the occasional influx of water

greatly influence the distribution and extent of riparian vegetation established within the Humboldt River floodplain. As described in Section 3.2.2.2, Barrick's discharges would temporarily increase flows in the Humboldt River. Increased water levels potentially could affect channel configuration, depth, and sinuosity that directly affect the distribution and extent of riparian vegetation.

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### 3.3.3 Monitoring and Mitigation

Based on the mitigation measures associated with the Betze Project Record of Decision (BLM 1991d), Barrick has funded mitigation of riparian and wetland areas potentially affected by dewatering of the Betze Pit (Betze Project Record of Decision, Exhibit C, Conservation and Mitigation of Riparian/Wetland Areas [BLM 1991d]). Barrick was obligated to contribute $660,000 to mitigate for the potential loss of riparian vegetation. Barrick also is committed to conduct long-term surface water monitoring activities (BLM 1991d).

If further reduction of surface waters were identified during the existing long-term surface water monitoring programs (see Section 3.2.3), Barrick would coordinate with the BLM to develop feasible water augmentation or improvement measures for affected springs or perennial stream reaches. This measure could include either on-site or off-site guzzler placements, small water pipelines, livestock fencing around existing surface water sources, etc. The feasibility of these options would be discussed relative to the riparian or wetland habitat value in the long term.

To provide off-site riparian or wetland habitat, Barrick would coordinate with the BLM to implement specific changes in the land use of the Squaw Valley Allotment. The specific components of this measure would be discussed among the BLM, Barrick, and the lessee, and appropriate improvement measures would be implemented on Barrick's property.

### 3.3.4 Residual Effects

Residual impacts to riparian vegetation would be avoided with the implementation of the monitoring and mitigation measures described in Section 3.3.3.

### 3.3.5 Irreversible and Irretrievable Commitment of Resources

Riparian and wetland vegetation affected by mine-induced drawdown would be irretrievably lost during the ground water recovery period. If ground water recovery occurs at spring locations and along creeks, the loss of riparian and wetland vegetation would be reversible; if riparian and wetland vegetation does not recover, the loss at these locations would be irreversible. However, offsite mitigation would compensate for these losses.

# 3.4 Terrestrial Wildlife

## 3.4.1 Affected Environment

### 3.4.1.1 Habitat

The study area for both the direct and cumulative impact analyses for terrestrial wildlife is composed of the cumulative assessment area described in Section 3.2.1, Water Resources and Geochemistry, Affected Environment. Representative species' lists and additional descriptions of terrestrial habitats associated with the study area and along the Humboldt River can be reviewed in a number of sources, including the Betze Project Draft EIS (BLM 1991a); BLM (1992, 1993b, 1996a); Bradley (1992); Neel (1994); Bradley and Neel (1990); Rawlings and Neel (1989); JBR (1990b, 1992a, b, g); Fox (1993), and ENSR (1995).

#### Dewatering and Localized Water Management Area

These studies have documented a diversity of wildlife resources that occupy the native upland sagebrush habitat, seeps and springs, perennial riparian areas, and modified habitats (e.g., agricultural lands, man-made wetlands, reclaimed communities, seeded grassland, burned areas, mining zones). The vegetation types or communities that comprise the primary wildlife habitats in the study area include upland sagebrush, juniper ridgelines, seeded grassland, and limited riparian habitats. The riparian habitat associated with wetlands, springs, and perennial stream channels is considered the highest value habitat for area wildlife. Available water for wildlife consumption and riparian vegetation for cover, breeding, and foraging are the predominant limiting factors for wildlife resources in northern Nevada. Therefore, riparian habitats, particularly those with multistoried canopies and open (free) water, typically support a greater diversity and population density of wildlife than the drier, upland habitats.

Surface water sources potentially available to wildlife are described in Section 3.2.1. The riparian habitats range from the limited lower-elevational wetlands, stock ponds, or isolated springs that are primarily composed of small, narrow drainages or moist soils with scattered patches of emergent vegetation to the higher-elevational springs that maintain a greater-value riparian habitat for wildlife use (JBR 1990a, b, 1992a, b) (see Section 3.3, Riparian Vegetation). The higher elevations of the Tuscarora Mountains, Independence Mountains, and, to a lesser extent, the Sheep Creek Range and Adobe Range support a variety of species that differ substantially from those generally found at the lower elevational water sources in the surrounding basins. Important habitat characteristics for both aquatic and terrestrial wildlife include the amount of open water; the extent of both herbaceous and woody vegetation, which is used for cover, foraging, and breeding activities; the quality of these plant communities, relative to the long-term use by wildlife (i.e., community longevity); and the diversity of plant species present.

Recent wildfire events in northern Nevada have seriously affected the native ranges for wildlife. These wildfires have resulted in decreased plant diversity and abundance, affecting the overall carrying capacity of the habitats and the wildlife that depends on them. Currently, the BLM is implementing reclamation and reseeding programs in conjunction with adjacent private landowners in order to improve range conditions and minimize cheatgrass invasions.

#### Humboldt River Basin

The Humboldt River is located within the largest watershed in Nevada. Habitats vary along the river corridor, ranging among wide floodplains, agricultural hay meadows, developed pastures, native willow and wild rose stands, natural sloughs, a limited number of trees, and steep cliff walls that intersect directly with the river. The diversity of wildlife species associated with these varied habitats along the river corridor has generally depended on the past settlement patterns, man-induced channelization projects, and land uses. As human populations along the basin have increased, vegetation modifications have resulted in associated changes to resident and migratory wildlife species. These activities have altered the overall landscape or the physical and biological character of the Humboldt system, thereby affecting the wildlife populations that depend on the floodplain and riparian habitats.

General habitat trends recorded along the Humboldt River indicate that some portions of the system have maintained overall ecological health, while others have deteriorated or the habitat conditions are currently in a downward trend (Bradley 1992; Neel 1994).

As with many river systems throughout the arid western United States, the Humboldt River supports a variety of wildlife species, ranging among waterfowl, shorebirds, small to large mammals, raptors, amphibians, and reptiles. Approximately 52 percent of the bird species recorded for the Humboldt River system were associated exclusively with the riparian habitat type, while only 3 percent of species observed were affiliated exclusively with upland communities (Rawlings and Neel 1989).

The Nevada Division of Wildlife (NDOW) initiated a program in 1983 to assess wildlife habitat values along the Humboldt River system floodplains and to measure, where feasible, the effects to those habitat values from human-related activities (Bradley 1992; Neel 1994). NDOW's wildlife and habitat studies extend downstream to Rye Patch Reservoir. Few data exist for the portion of the Humboldt River downstream of Rye Patch Reservoir to the Humboldt Sink. Wildlife surveys were designed to determine overall species' occurrence and habitat preferences. These survey results are detailed in Bradley (1992), Neel (1994), and Bradley and Neel (1990) and are summarized in Rawlings and Neel (1989).

Habitats along the Humboldt River can be broadly categorized as riparian-wetland or upland habitat types. The riparian-wetland habitat includes the willow, rose, bulrush, cattail, meadow, and cottonwood communities, in addition to the river channel and on-channel ponds. The upland habitat includes the saltgrass, wildrye, greasewood-rabbitbrush, upland shrub, and annual weed communities. The buffaloberry community is classified in a third, separate category because of its unique properties, as discussed below (Rawlings and Neel 1989). The type and availability of these plant communities are primary factors in determining overall wildlife distribution along the Humboldt River (Rawlings and Neel 1989; Bradley 1992; Neel 1994).

The descriptions for the Humboldt River system focus on the riparian-wetland habitat type, since available water and the riparian-wetland vegetation (which provide cover, forage, and breeding areas) are limiting factors for both resident and migratory wildlife in Nevada.

Willow communities are considered one of the most valuable wildlife habitats. The greatest diversity of wildlife species along the Humboldt River has been recorded within the willow community, particularly for bird species (Rawlings and Neel 1989). Willows provide both vertical and horizontal structure for breeding sites, escape cover, and thermal cover and are important to maintaining bank stability. Willows aid in maintaining and building floodplains, since they are a primary pioneering species that can become established on stream deposits following flood events. The capability of either directing or absorbing floodwaters is important in maintaining quality wildlife habitat, and some sections of the Humboldt River and its tributaries have lost much of their ability to store floodwaters. If willows were removed or inhibited from establishing along the riverbank, stream deposits may remain unvegetated and inherently unstable (Bradley 1992). Willow stands often support a mid-story of rose and currant, with an understory of bulrush, cattail, rushes, sedges, and meadow grasses. Because of the available cover, willows provide primary wildlife movement corridors along the river system.

Cottonwood communities are scattered along the river corridor. This community provides additional canopy structure for avian species, particularly during the breeding season. In some locations along the Humboldt River, heron rookeries occur in cottonwood trees (Bradley 1992).

Another community that is valuable to wildlife is dominated by buffaloberry. The majority of buffaloberry within the project region occurs in portions of Humboldt and Pershing counties. Buffaloberry exhibits characteristics of both the riparian-wetland and upland habitat types, resembling more of a riparian-wetland type, but typically occupying drier portions of the floodplain that generally support more upland plant species. Buffaloberry stands provide additional vertical structure and often support the higher-value, mid-, and understory species (e.g., wild rose, currant, and annual forbs), which supply a quality food source for wildlife (Neel 1994). A multi-storied buffaloberry stand also may approach the diversity of bird species recorded for the willow community (Rawlings and Neel 1989).

Subsequent to manipulations by humans for irrigation and livestock grazing, areas along the Humboldt River were converted to hay meadows. Vegetation composition within these meadows can vary, depending on soil moisture, ranging from wet meadows to drier, more upland areas. Wet hay meadows often provide marsh-like habitat, which generally receives more use from shorebirds, waterfowl, raptors, etc., than the drier meadows that are dominated by annual grasses found in the more upland sites. The wet meadows support the highest avian species diversity, second only to the willow community. These meadows provide critical foraging and nesting habitat for a number of species of waterfowl, shorebirds, passerines (i.e., songbirds), and raptors along the Humboldt River. Even higher species diversity has been recorded in wet meadow or buffaloberry communities interspersed with willow stands (Rawlings and Neel 1989).

As discussed in Section 3.2.1.3, the sinuosity of the Humboldt River varies dramatically from human-induced changes. A greater sinuosity typically equates to higher wildlife habitat values, species diversity (i.e., species richness or variety), biodiversity (i.e., a greater genetic diversity or variation relative to the structure and community composition), and species density (i.e., numbers of animals within an area).

Historically, wetland conditions were created by meander scars and old oxbows, which intersected with ground water and maintained open or available water for long periods of time. Currently, cattail, bulrush, and some willow stands are generally limited to the remaining meander scars and oxbows along the river channel. Ponded water in these areas provides important nesting, brooding, foraging, and resting habitat for other water-dependent species. Fish may become trapped during low-flow periods, providing increased prey availability for bird and mammal predators, such as mink, otter, great blue heron, bald eagle, etc. (Bradley 1992; Neel 1994).

The past changes to and channelization of the Humboldt River system that have occurred since settlement along the river corridor are described in Section 3.2.1.3. A net loss of 13.4 miles of river length has resulted, particularly in the Dunphy and Argenta areas, in addition to the river reach downstream of Winnemucca. The straightening of the river channel for the Humboldt Project, which was designed to deliver increased water flows to the Lovelock Valley for irrigation purposes, resulted in a reduction in channel sinuosity, thereby reducing the availability of wetland habitats, open water areas, and riparian vegetation typically associated with these habitat types. Further erosion also has resulted in increased channelization. As the floodplains are dewatered by increased channelization, vegetative changes occur, resulting in a loss of riparian vegetation; encroachment of drier, upland plants; and a greater propensity to flooding.

The Argenta Marsh was located near Battle Mountain. Historically, the marsh provided valuable habitat used by large numbers of migratory waterfowl, shorebirds, and passerines (Bradley 1998). In the 1950s, the Humboldt drainage was channelized to drain the marsh. The majority of the 2,600 acres of the bulrush community and an unknown amount of native hay and willow communities, which had been historically associated with the Argenta Marsh and Rock Creek, were lost during this channelization effort. The current habitat conditions of the marsh area and Rock Creek are more structured for upland wildlife species. Willow regeneration along Rock Creek is low to none from the willow eradication programs previously implemented along the channel, combined with the past and current livestock grazing pressure. These activities dramatically reduced the relative habitat value for wildlife species typically associated with the wetland communities along this river reach (Bradley 1992).

An area along the Humboldt River east, or upstream, of the Comus Gage near the Herrin Slough supports large stands of hardstem bulrush, dense willow stands, and sufficient woody and herbaceous understory plants to provide valuable cover, breeding sites, and forage for a wide diversity of wildlife species. The

Herrin Slough is an area of braided, low-gradient channels in the Humboldt River floodplain. Many of the wildlife species associated with this area (e.g., great blue heron, snowy egret, gadwall, Wilson's phalarope, Virginia rail, yellow warbler, black-headed grosbeak, lazuli bunting) are indicative of a healthy community along the Humboldt River corridor (Neel 1994). Beaver, river otter, and mountain lion were recorded in this area in 1988. Mountain lions are rare along the Humboldt River because of the lack of adequate cover along a majority of the river corridor. This area upstream of the Comus Gage and northwest of Valmy likely represents one of the few river reaches capable of supporting a mountain lion for any extended period of time (Neel 1994).

Immediately downstream of the Comus Gage near Golconda, extensive bulrush-cattail communities support a high diversity of wildlife species. River channel meanders and oxbows are still present and dense willow stands occur along the river channel, contributing increased breeding sites, cover, and foraging potential for wildlife (Neel 1994).

Rye Patch Reservoir provides limited habitat value for terrestrial wildlife. Because of the water depth and limited amount of shoreline and shallow, littoral habitat, the reservoir mainly provides resting areas for waterfowl and some shorebirds and available water for a large variety of other species. The Pitt-Taylor Reservoirs, which hold additional storage for Rye Patch Reservoir, provide a greater habitat value for both resident and migratory wildlife. These smaller reservoirs are consistently more shallow than Rye Patch, maintain a greater amount of shallow-water shoreline habitat, and periodically dry out, thereby increasing plant productivity and food production for wildlife, particularly migratory waterfowl and shorebirds. Increased forage production is partly because of the shallow depths and the increased oxygenation from fluctuating water levels. In 1993-1994, the Pitt-Taylor Reservoirs supported approximately 800 pairs of white-faced ibis (Neel 1998).

The portion of the Humboldt River upstream of Lovelock provides some valuable habitat for wildlife resources; however, portions of this area have been compromised by tamarisk invasion. Increasing channelization and irrigation diversions for agricultural activities within the Lovelock Valley have reduced the amount of native wetland habitats for wildlife resources. Although substantial agricultural activities are ongoing in the Lovelock Valley, the river corridor and upland areas continue to provide habitat for both resident and migratory wildlife species. In addition to the riparian habitat along the river, the agricultural fields provide some forage and cover, depending on the season and environmental conditions. Fallow agricultural fields (from November to April) within the Lovelock Valley are often invaded by ground squirrels, which attracts large concentrations of migrating raptors (Neel 1994, 1998). Downstream of Lovelock, great blue heron rookeries containing up to 25 nests have been documented (Neel 1998). Other areas along the river downstream of Lovelock support dense stands of willow; however, the incidence of this plant community is less than that observed upstream of Lovelock.

### Humboldt Sink and Carson Sink

The Humboldt Sink is the closed-basin terminus of the Humboldt River. The Humboldt Wildlife Management Area (WMA), covering 36,235 acres, is located in the Humboldt Sink directly north of the Fallon National Wildlife Refuge and approximately 20 miles north of the Stillwater WMA. The Humboldt WMA was established in 1954 as a primary feeding, nesting, and resting area for migratory birds associated with the Pacific Flyway. It is considered one of the most important wildlife habitats in Nevada and is currently managed by the NDOW.

The Humboldt WMA encompasses three wetland units, including Toulon Lake and both the upper and lower portions of Humboldt Lake (see Figure 3.2-20). Birds typically move among all of these sites (Seiler et al. 1993). Species diversity recorded at the Humboldt WMA parallels that documented within the Lahontan Valley, which supports over 200 bird species, most of these species being migratory (Seiler and Tuttle 1997).

The wetlands systems associated with the Humboldt Sink are generally characterized by wet and dry cycles and vary in size and depth on an annual basis. In 1990, the wetland surface area averaged 12,850 acres. The most common vegetation recorded for the Humboldt Sink wetlands include alkali bulrush, cattails, sago pondweed, and muskgrass (Seiler et al. 1993).

The Humboldt Sink is of greater value for wildlife resources than the Carson Sink. The Carson Sink is considered to be of marginal value for waterfowl because of the lack of adequate foraging opportunities and high salinity levels in this basin (Saake 1998). Water flow from the Humboldt Sink south into the Carson Sink only occurs during high-flow years (e.g., operational releases, increased precipitation). During these high-water events, the increased flow into the Humboldt WMA flushes the wetlands systems, removing accumulated salts. Water flushed from the Humboldt Sink moves south into the Carson Sink. The water in this closed basin ultimately evaporates, concentrating the dissolved water constituents (e.g., salts, metals) over time (Seiler et al. 1993). Constituents tied to the soils may be subsequently removed from the area by wind action across the Carson Sink (and dry portions of the Humboldt Sink), dispersing them across a large area located predominantly to the east of the basin areas (Saake 1998). The quantity of constituents removed by wind erosion is not well documented in the sink. However, in other regions, wind removal has been found to account for up to several million tons a year of material (Feshbach and Friendly 1992).

### 3.4.1.2 Game Species

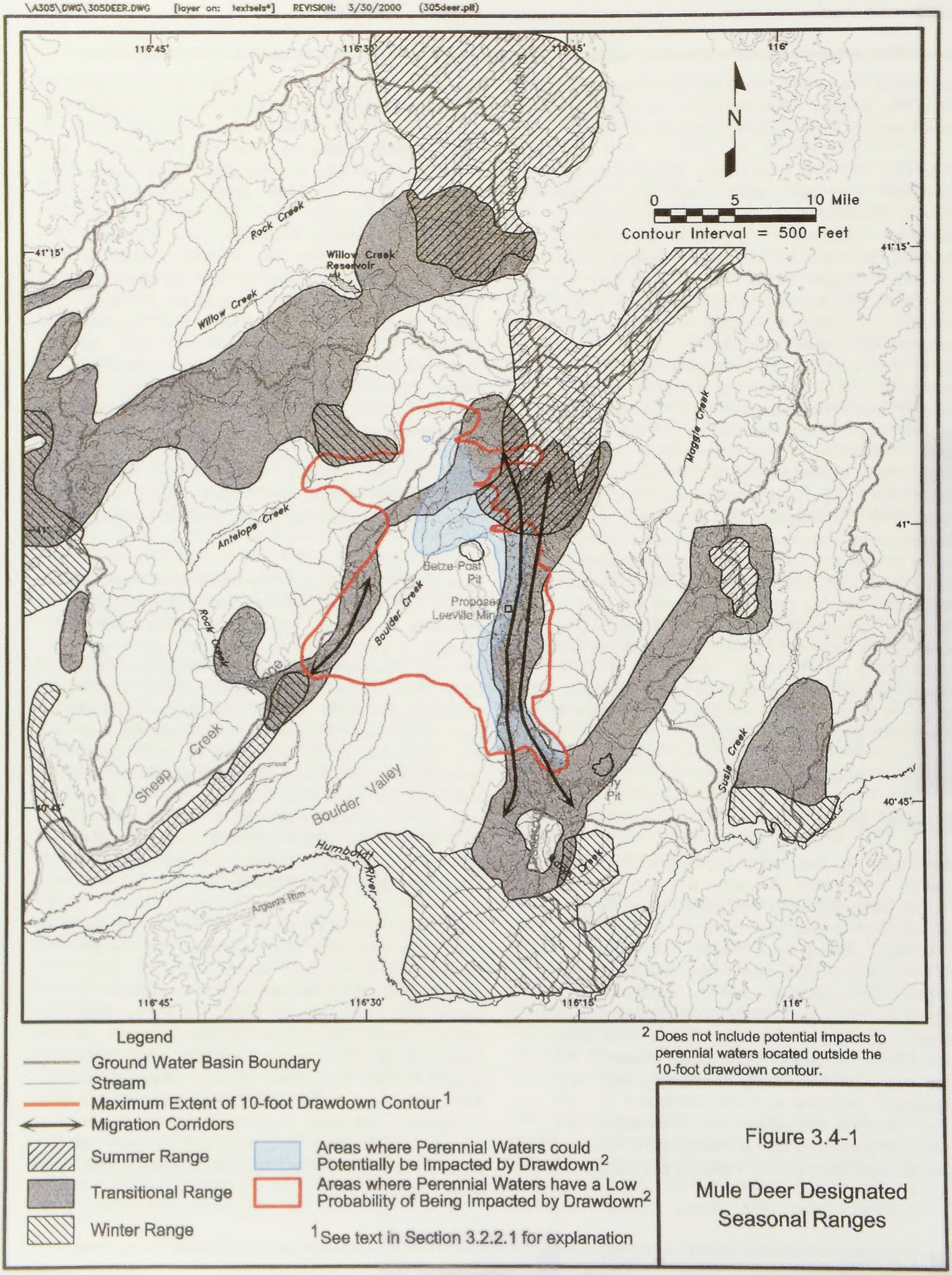
#### Big Game Species

Mule deer is the most prominent big game species in northern Nevada. The Management Area 6 deer herd that occupies the study area experienced population declines in the past, particularly during the 1992-93 winter season (NDOW 1996a). Mule deer winter and transitional ranges have been affected by wildfires in the project region (Lamp 1999; BLM 2000a). Winter range is considered to be the most limiting factor for the deer population (BLM 1992). However, the herd has been increasing in recent years. This population increase is partly attributed to mild winter seasons and successful rehabilitation of a portion of the winter range, resulting in increased fawn survival rates (Lamp 1999; BLM 2000a).

Seasonal ranges and movement corridors for mule deer that have been documented by NDOW for the area (JBR 1995a; BLM 1992, 1993b, 1996a; NDOW 1998a) are shown in Figure 3.4-1. These areas of use include deer winter range, summer range to the north, intermediate (transitional) range, and the migration or movement corridors between these seasonal ranges (NDOW 1998a). The importance and use of these ranges in any year to the mule deer herd typically depends on such variables as snow depth, forage availability, cover, and weather patterns. The Sheep Creek Range and the Tuscarora Range to the west and east of Boulder Valley, respectively, provide important regional migration corridors for deer. The specific range designations by NDOW and BLM, levels of use, and movement patterns, are described in more detail in JBR (1995a), BLM (1992, 1993b), NDOW (1993a), and the State's annual Herd Composition Survey Narrative, available through NDOW.

Mule deer movements in the transitional habitats of the Tuscarora Mountains along the eastern boundary of Boulder Valley have shifted within the last 11 years. Prior to 1987, deer used both the east and west sides of the range to move south into winter range from summer range located to the north. Since 1987, the majority of deer movement has shifted to the east flank of the mountains along a portion of their route. Although area wildfires have reduced the overall quality of the mule deer habitat along the west side of the Tuscaroras (BLM 1992, 1993b; NDOW 1993a), NDOW primarily attributes the shift in the migratory pattern to mine development along the Carlin Trend (NDOW 1993a).

Transitional range provides valuable habitat for mule deer between their summer and winter ranges. In years with limited or late snow accumulation, the deer remain on the transitional range until snow depths force them into their winter ranges. The longer the deer remain on these transitional ranges, feeding on higher quality forage, the better condition they are in when they move to the lower quality winter range. In addition, the delay in animals arriving on the winter ranges also reduces the amount of pressure on this winter habitat (NDOW 1993a; BLM 1993b, 1996a).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116°45'
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Contour Interval = 500 Feet
Rock Creek
Willow Creek Reservoir
Willow Creek
Antelope Creek
Boulder Creek
Betze Post Pit
Proposed Leeville Mine
Rock Creek
Sheep Creek
Boulder Valley
Maggie Creek
Susie Creek
Pit
Humboldt River
Argenta Rim
Legend
Ground Water Basin Boundary
Stream
Maximum Extent of 10-foot Drawdown Contour¹
Migration Corridors
Summer Range
Transitional Range
Winter Range
Areas where Perennial Waters could Potentially be Impacted by Drawdown²
Areas where Perennial Waters have a Low Probability of Being Impacted by Drawdown²

[1] See text in Section 3.2.2.1 for explanation

[2] Does not include potential impacts to perennial waters located outside the 10-foot drawdown contour.

Figure 3.4-1

Mule Deer Designated Seasonal Ranges

Mountain lion also is a big game species. The relative presence or absence of lions within the study area is generally regulated by distribution of the mule deer population.

Pronghorn occur throughout the study area (JBR 1995a; BLM 1993b), but have only been recorded in any concentrations since the mid-1980s (BLM 1992; JBR 1995a). The northern portion of Boulder Valley is classified as pronghorn winter range, summer, and transitional ranges (Figure 3.4-2) (NDOW 1998a; BLM 1993b). The recently developed agricultural fields (i.e., alfalfa) also may be used by pronghorn to a limited extent (JBR 1995a). Increased fawn survival combined with recent mild winters have contributed to an upward trend in the population numbers; however, the limiting factor for resident pronghorn is available winter range (BLM 2000a). The distribution of pronghorn within the study area is dynamic, changing annually, partly because of the effects from wildfires, wildfire rehabilitation, and the increased agricultural uses of Boulder Valley.

California bighorn sheep occur within the region. As depicted in Figure 3.4-3, a small population of bighorn predominantly occupy portions of the Sheep Creek Range to the west of Boulder Valley (NDOW 1998a).

### Upland Game Birds

Upland game birds identified in the study area include sage grouse, chukar, gray (Hungarian) partridge, mourning dove, wild turkey, California quail, and ring-necked pheasant (BLM 1993b; JBR 1989, 1990a, b, 1992a; Neel 1994; Teske 1999). Sage grouse are considered a BLM-sensitive species, and are described in Section 3.6. Chukar are typically associated with more rugged slopes, canyons, and drainages in fair proximity to open water. The gray (Hungarian) partridge is considered widespread but not common and is associated with grasslands, shrublands, and agricultural areas. Mourning doves are more commonly found near water sources, generally nesting in shrubs and trees (Terres 1991). The NDOW released about 44 wild turkeys near Beowawe in 1997 and approximately 25 birds on the TS Ranch in 1999 (Teske 1999). The current distribution of these birds is unknown, but it is assumed that some individuals currently occupy suitable habitat (e.g., woodland areas). California quail previously occurred along the Humboldt River, but the past declines in habitats used for cover have resulted in a reduction in distribution and population numbers (Teske 1999).

### Waterfowl

Other game species identified for the study area include a number of waterfowl species associated with the Pacific Flyway. Historically, waterfowl numbers were not high in the Little Boulder basin (e.g., larger spring complexes, Willow Creek Reservoir, perennial streams); however, the incidence of use and number of birds have increased during the last decade. This increase was attributed to TS Ranch Reservoir and mounding of ground water resulting in the formation and expansion of Green, Sand Dune, and Knob springs (see Figure 3.2-1). Increased surface water availability and increased emergent and submergent vegetation in Boulder Valley have provided additional foraging, cover, resting, and breeding habitats for bird species, particularly waterfowl and shorebirds.

To record relative levels of avian use in Boulder Valley resulting from the increased water availability, three aerial surveys were conducted in 1995 (ENSR 1995) that focused on TS Ranch Reservoir and the three springs. Bird surveys were conducted during February, April, and August by helicopter and subsequently confirmed by ground visits. These surveys recorded a number of species of waterfowl and shorebirds using these areas. Common waterfowl observed included American coot, green-winged teal, blue-winged teal, mallard, gadwall, ruddy duck, redhead, and eared grebe. Shorebirds are discussed below for nongame species. Bird counts totaled 2,395, 2,422, and 1,815 for February, April, and August, respectively. After 1995, the number and diversity of birds declined as surface water at TS Ranch Reservoir and the springs was reduced (see Sections 3.2.2.1 and 3.3).

In 1999, water discharges into the reservoir resumed; however, during the first quarter of 1999, spring flows were approximately 25 percent of the levels measured in 1995 (Barrick 1999a). It is assumed that the number of waterfowl using

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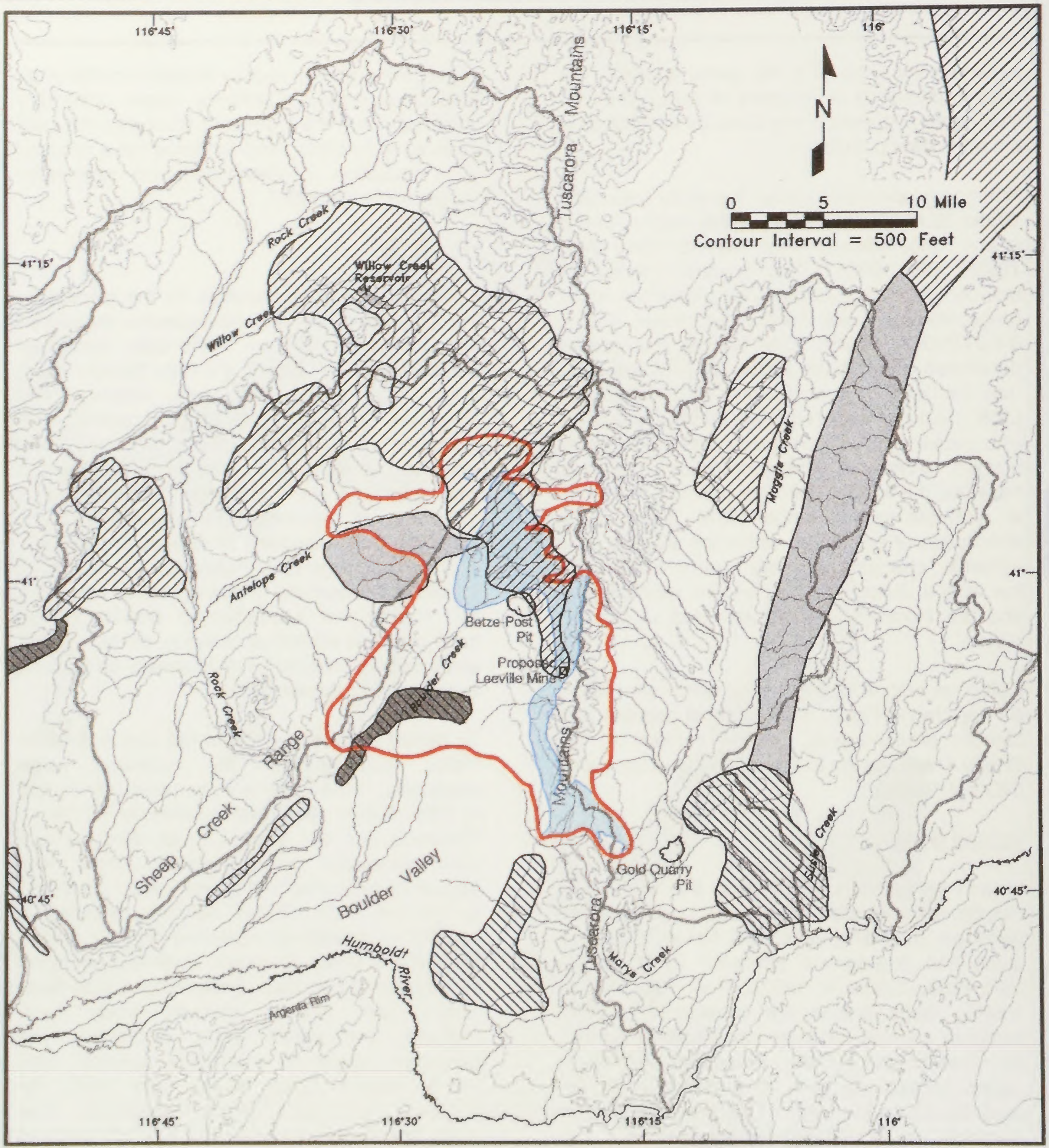

Legend

Ground Water Basin Boundary

Stream

Maximum Extent of 10-foot Drawdown Contour [1]

▨ Summer Range

▨ Transitional Range

▨ Winter Range

■ Yearlong Range

Areas where Perennial Waters could Potentially be Impacted by Drawdown[2]

Areas where Perennial Waters have a Low Probability of Being Impacted by Drawdown[2]

[1] See text in Section 3.2.2.1 for explanation

[2] Does not include potential impacts to perennial waters located outside the 10-foot drawdown contour.

Figure 3.4-2

Pronghorn Designated Seasonal Ranges

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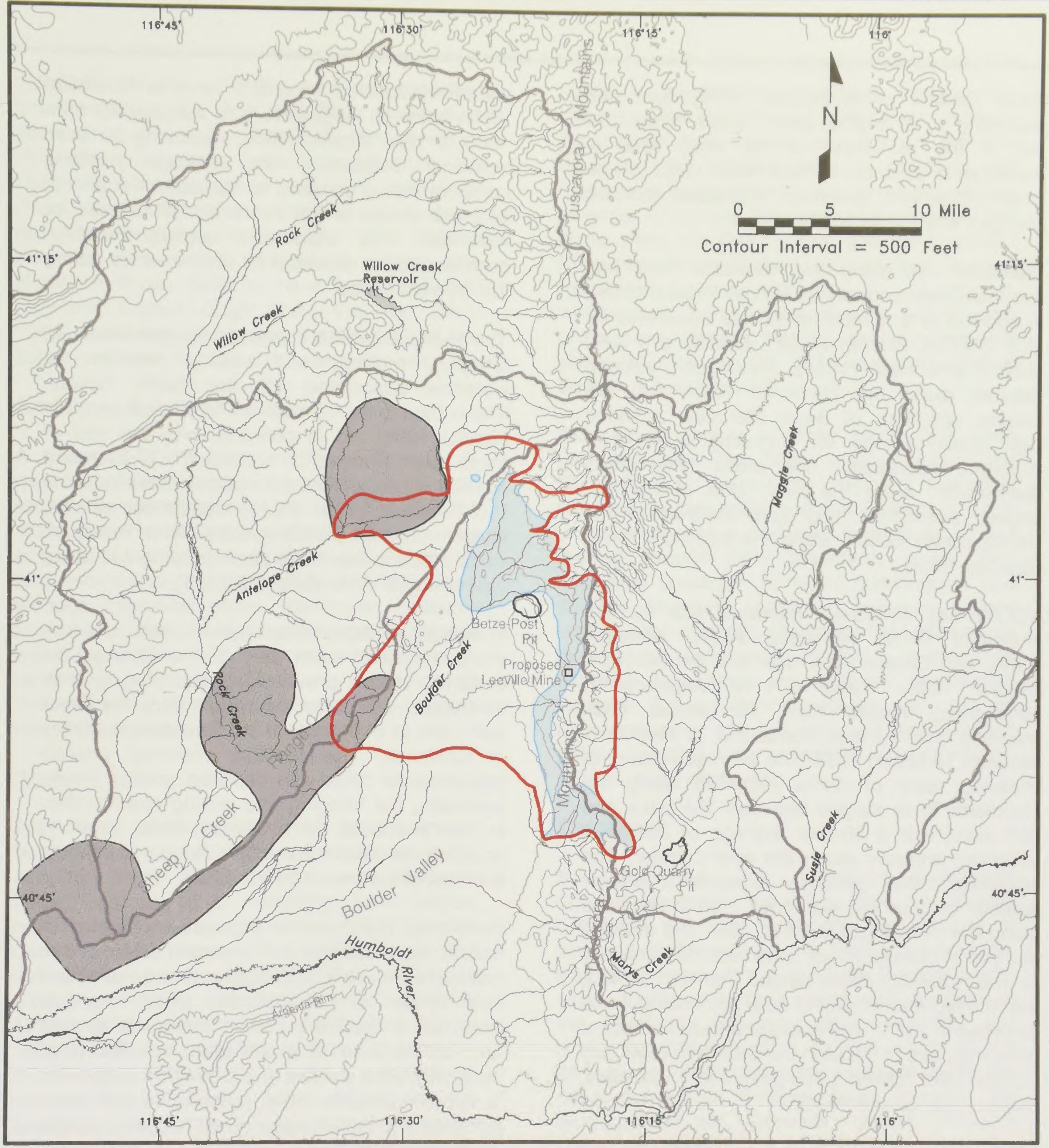

Legend

— Ground Water Basin Boundary

— Stream

— Maximum Extent of 10-foot Drawdown Contour[1]

▨ Yearlong Range

▭ Areas where Perennial Waters could Potentially be Impacted by Drawdown[2]

▭ Areas where Perennial Waters have a Low Probability of Being Impacted by Drawdown[2]

[1] See text in Section 3.2.2.1 for explanation

[2] Does not include potential impacts to perennial waters located outside the 10-foot drawdown contour.

Figure 3.4-3

California Bighorn Sheep Designated Range these habitats within Boulder Valley fluctuates according to changing water levels. Waterfowl use in the remainder of the study area is restricted to available surface water (e.g., Willow Creek Reservoir, perennial drainages, isolated springs), which is relatively limited.

Waterfowl use along the Humboldt River has been recorded annually by NDOW (Saake 1998), in addition to a number of studies completed by JBR (1992b); Bradley (1992); Bradley and Neel (1990); and Neel (1994). Historically, wetland habitats along the Humboldt River that are located upstream of Battle Mountain provided high quality forage for migrating ducks and important migrational use areas have been documented along the river. One of the four largest canvasback migration corridors in the United States occurs along the Humboldt River (Bradley 1992).

NDOW has collected waterfowl data for the Humboldt River, Humboldt WMA, Stillwater WMA, and Carson Lake over the last 30 years (Saake 1998). Table E-1 in Appendix E summarizes results from the annual duck breeding pair surveys conducted in Region 1 between 1959 and 1998. The average number of breeding pairs of ducks recorded along the Humboldt River ranged between 154 pairs and 365 pairs, with a 30-year average of 266 pairs observed annually along the river corridor. The Humboldt WMA generally supports a greater number of breeding waterfowl than is recorded along the river. From 1959 to 1998, the average number of breeding duck pairs recorded annually for the Humboldt WMA ranged from 161 to 472, with the highest number of duck pairs being 1,049 recorded in 1977. The average annual number of breeding pairs of ducks in the Stillwater WMA and Carson Lake totaled 1,760 pairs and 1,059 pairs, respectively (Saake 1998).

The average annual waterfowl counts for the Humboldt WMA, Stillwater WMA, and Carson Lake are summarized in Table E-2 in Appendix E. The mean number of waterfowl recorded annually between August 15 and January 30 at the Humboldt WMA, Stillwater WMA, and Carson Lake from 1968 to 1997 totaled 2,232,000; 7,723,000; and 4,428,000 individuals, respectively (Saake 1998). Table E-3 in Appendix E summarizes the average number of waterfowl species recorded for the Humboldt WMA between August 15 and January 30 from 1969 to 1998 (Saake 1998). Assuming an even seasonal distribution, the average yearlong numbers also are shown to represent the annual estimate of use of the Humboldt WMA area by waterfowl. This table also depicts the high number of birds recorded for each species during this 30-year period.

The Humboldt WMA provides valuable breeding, foraging, molting, and resting habitats for waterfowl associated with the Pacific Flyway. These data collected over the last three decades (Saake 1998) aid in characterizing the use of these basin systems by waterfowl and shorebird species. In addition to the species listed in Table E-3, American coots, double-crested cormorants, western and/or Clark's grebes, and American white pelicans also have been documented using the Humboldt WMA (USFWS 1999).

In addition to migrants using these wetland areas along the north-south axis of the Flyway, the wetland systems provide a critical staging area for migratory birds as they move from the Great Salt Lake in Utah west to the Sacramento Valley of California. The terminal wetlands provide resources for birds with depleted energy levels, optimizing the foraging and resting opportunities in the Humboldt and Carson Sinks prior to crossing the Sierra Mountain Range located to the west of the basin (Saake 1998).

Seiler et al. (1993) identified possible indicators of habitat degradation at the Humboldt WMA. These indicators included: (1) increased bird mortalities from epizootics that generally affect migratory birds; (2) a decline in native emergent species and an increase in exotic plant species (e.g., tamarisk); (3) a decline in submergent vegetation in upper Humboldt Lake, resulting in less sago pondweed (a good forage plant) and an increase in more salt-tolerant species (e.g., muskgrass); and 4) a reduction in species diversity within the wetlands for both vertebrates and invertebrates.

### Furbearers

The beaver, an important species for riparian systems, occurs along the Humboldt River. Historically, beaver have been responsible for channel modifications from their dam building activities (Bradley 1992). Another important furbearer along the Humboldt River is the river otter, which is closely associated with the willow community. A limiting factor for otter along the Humboldt River appears to be den-site availability (Neel 1994). Mink and muskrat have been reported along the river corridor (JBR 1992b). Bobcats also occur sporadically along the Humboldt River. Bobcats have been confirmed near the Comus Gage along the river (Neel 1994), indicating a higher quality habitat that can support both the bobcat and its prey species.

#### 3.4.1.3 Nongame Species

A diversity of nongame wildlife species (e.g., raptors, passerines, small mammals, amphibians, reptiles) is associated with the habitats within the study area. Passerines (songbirds) are numerous and use the entire range of the native habitats (e.g., sagebrush, riparian, grassland, shrubland, wooded uplands) and man-made features (agricultural lands, bridges, abandoned buildings) within the region. The open, arid terrain supports large and varied populations of small mammals that comprise the prey base for the region's mammalian predators and raptor species.

##### Raptors

Area raptor species include the more common buteos (e.g., red-tailed hawk, ferruginous hawk), accipiters (e.g., sharp-shinned hawk, Cooper's hawk), eagles (e.g., wintering bald eagles, nesting golden eagles), falcons (e.g., prairie falcon, American kestrel), the northern harrier, the turkey vulture, and owl species (e.g., short-eared owl, great-horned owl, long-eared owl) (BLM 1993b, 1996a; Herron et al. 1985; JBR 1992a, 1995b, 1996a). In addition to these raptors, the rough-legged hawk is a winter resident in northern Nevada (Herron et al. 1985), and the peregrine falcon may forage along the riparian corridors (e.g., Humboldt River). This falcon also has been documented near the Humboldt Sink (Seiler et al. 1993; Seiler and Tuttle 1997).

A number of raptors has been reported in and around the study area. Species observed include the golden eagle, red-tailed hawk, ferruginous hawk, prairie falcon, northern harrier, burrowing owl, and short-eared owl. Based on the size and diversity of the study area, the overall raptor use spans a number of vegetative communities, geological features, and variable terrain between the basins and ranges of northern Nevada. Several raptor species are both residents and migrants in the study area and may nest, forage, or winter throughout the diverse communities that occur along the Carlin Trend and the Humboldt River downstream to the Humboldt Sink. General raptor species are addressed in this chapter, relative to their habitat associations and foraging preferences. Raptors that are considered special status species by the BLM are discussed in Section 3.6 of this SEIS.

Although a number of raptor nests have been recorded within the study area, including the Humboldt River system, the location of these nest sites are not delineated in this document, in order to protect the sites and their inhabitants. These nesting records are important, since they document presence, historical distributions, and suitable breeding habitats. However, since raptors often maintain alternative nest sites within their respective breeding territories or they may establish new nests in previously unoccupied habitats, these historical records are used as references only, and it is assumed that breeding pairs may occupy any potentially suitable nesting site within the study area.

##### Shorebirds

As discussed for waterfowl, shorebird occurrences within the study area are directly correlated with the availability and amount of surface water resources. In 1995, shorebird use was considered high in the Little Boulder basin, when additional surface water was available at the TS Ranch Reservoir, at the springs, and along the irrigation ditch located south of the springs. Common shorebirds recorded during the aerial surveys of Boulder Valley included the black-necked stilt, American avocet, Wilson's phalarope, and killdeer. White-faced ibis also were recorded (ENSR 1995) and are discussed further in Section 3.6, Threatened, Endangered, Candidate, and Sensitive Species. Subsequent to the surveys, water levels in TS Ranch Reservoir were reduced. This reduction in surface water availability and, therefore, the riparian community in Boulder Valley reduced the amount of suitable habitat for resident and migratory shorebird species. The decline in suitable habitat at TS

Ranch Reservoir, at the three Boulder Valley springs (i.e., Knob, Green, and Sand Dune), and along the irrigation canal south of the springs reduced shorebird numbers in the valley, as these wetland areas reverted back into more upland communities. As discussed previously, water levels in the reservoir have increased, and measured spring flows in the first quarter of 1999 were approximately 25 percent of the 1995 levels (Barrick 1999a). It is assumed that future shorebird use would correlate with water availability in this valley, as well in the surrounding study area.

A large number and diversity of shorebirds are associated with the Humboldt River and the Humboldt Sink. Several documents summarize common shorebird species recorded along the river corridor and at the Humboldt WMA (e.g., great blue heron, black-crowned night-heron, killdeer, spotted sandpiper, American avocet, black-necked stilt) (JBR 1992b; Bradley 1992; Bradley and Neel 1990; Neel 1994; USFWS 1999). Unique or uncommon species reported along the river include the long-billed curlew, greater sandhill crane, snowy egret, great egret, Virginia rail, white-faced ibis, and black tern. Additional unique shorebird species identified farther downstream include the American bittern, a secretive heron that is typically associated with bulrush-cattail marshes, and the American white pelican, recorded directly upstream of Rye Patch Reservoir. During the 1988 NDOW surveys, one sighting of an American bittern was made downstream of the Lander-Humboldt County line (Neel 1994). Discussions for the American white pelican, white-faced ibis, and black tern are presented in Section 3.6, Threatened, Endangered, Candidate, and Sensitive Species.

The long-billed curlew is a large shorebird species that has been declining within the Great basin. In Nevada, this shorebird is often associated with grazed meadows and wetland pastures. Along the Humboldt River, this species is often recorded feeding in irrigated hay meadows (Neel 1994). In 1987, curlew nesting was confirmed along the Humboldt River in Lander County, and birds were observed near Battle Mountain during the breeding season (Bradley 1992). In 1988, this bird was observed during the breeding season near the Comus Gage (Neel 1994).

In 1987, greater sandhill cranes were observed along the Humboldt River near Battle Mountain in Lander County during the breeding season (Bradley 1992). Snowy egrets have been recorded along the Humboldt River (Bradley and Neel 1990; Bradley 1992; JBR 1992b; Neel 1994). After near extirpation at the turn of the century, egret populations have recovered. Sightings have been recorded upstream of the Comus Gage (Bradley 1992; Bradley and Neel 1990; JBR 1992b) and near the town of Winnemucca downstream of the Comus Gage (Neel 1994). Great egrets also were recorded by the NDOW in 1988 near Golconda and farther downstream near Winnemucca (Neel 1994). Egret species found along the Humboldt River are often closely associated with the hardstem bulrush community, which has been decreasing along the river corridor (Neel 1994).

In 1988, a juvenile Virginia rail was documented along the Humboldt River near the Herrin Slough. This sighting coincided with the presence of stands of hardstem bulrush along the river. This shorebird species also was documented in 1988 farther downstream near Winnemucca (Neel 1994).

### Songbirds

A variety of songbirds occupy a wide range of habitat types in northern Nevada. As discussed above, the riparian-wetland community primarily associated with naturally occurring springs within the study area, the Humboldt River, and the Humboldt Sink supports a greater diversity of species than the surrounding upland communities. The BLM Elko Field Office estimates that approximately 75 percent of the songbirds (185 species) identified for the Field Office area either directly depend on riparian habitats or utilize them to a greater extent than adjacent upland communities. Bradley (1992), Neel (1994), Bradley and Neel (1990), Rawlings and Neel (1989), and JBR (1990b, 1992a, b, g) contain species lists of representative songbirds recorded for the entire study area.

Three uncommon avian species that are closely associated with the habitat types in this system include the yellow-breasted chat, marsh wren, and loggerhead shrike. The chat is considered an indicator species of the relative health and availability of riparian habitat types along the Humboldt River and has been identified as one riparian-associated species that would most likely decline with the removal of riparian vegetation (Sedgwick and Knopf 1987). In 1987 and 1988, yellow-breasted chats were documented during NDOW's Humboldt River studies near Battle Mountain in Lander County (Bradley 1992; Bradley and Neel 1990) and near the Herrin Slough and Golconda in Humboldt County (Neel 1994). The marsh wren also is considered an indicator species, but more for the hardstem bulrush and cattail communities, which are becoming more uncommon in Nevada. This wren species was documented by NDOW along the Humboldt River in 1988 near Battle Mountain in Lander County (Bradley and Neel 1990). Loggerhead shrike populations are reported to be in decline in portions of their range. This bird species was reported by the NDOW in 1988 along the Humboldt River west of Battle Mountain in Humboldt County (Neel 1994).

Other important avian species indicative of high quality riparian habitats (e.g., dense willow, rose thickets) and recorded during NDOW's surveys included the yellow warbler, common yellowthroat, black-headed grosbeak, blue grosbeak, lazuli bunting, and house wren (Neel 1994).

**Mammals**

Numerous nongame mammal species occur throughout the study area, occupying a variety of habitat types and elevations. Representative nongame species that inhabit the sagebrush, juniper woodland, grassland, and riparian communities within the study area include the raccoon, badger, porcupine, skunk, coyote, black-tailed jackrabbit, and a variety of rodent and bat species.

An important group of nongame species of concern includes resident and migratory bat species. Bat hibernacula, nursery colonies, and individual roost sites likely occur throughout the study area. Bat surveys were conducted in 1995 and 1996 along selected riparian habitats (e.g., streams, wetlands, stock ponds, riparian corridors) located in Boulder Valley (Ports 1995, 1996). These surveys focused on the potential presence of certain bat species and their use of riparian areas. Surveys also have been conducted east of the Tuscarora Mountains (BLM 1993b, 1996a). Bat species documented during these surveys from trapping activities and echolocation recordings included the small-footed myotis, long-eared myotis, western pipistrelle, big brown bat, and Townsend's big-eared bat. Three bat species documented in the Independence Mountains include the long-legged myotis, long-eared myotis, and small-footed myotis (BLM 1996a). Additional bat species likely to occur within the region include the pallid bat and possibly the silver-haired bat, based on range, distribution, and previous trapping studies (Ports 1995; Ports and Bradley 1996). Additional sensitive bat species are discussed further in Section 3.6, Threatened, Endangered, Candidate, and Sensitive Species.

**Amphibians and Reptiles**

Amphibians and reptiles in the region are limited because of the cool, dry climate (BLM 1993b). Amphibians are generally associated with aquatic habitats; reptiles occupy drier upland habitats but use the mesic riparian habitats for foraging. The majority of the reptiles and amphibians recorded for the study area are considered to be common (BLM 1993b), except for the Columbian spotted frog, which is discussed further in Section 3.6, Threatened, Endangered, Candidate, and Sensitive Species.

## 3.4.2 Environmental Consequences

### 3.4.2.1 Overview

Impacts to terrestrial wildlife from the implementation of Barrick's current and future water management operations depend on the project component, the anticipated process or procedures during mine operation, and relative species' sensitivity. As discussed in the Betze Project Draft EIS, impacts to wildlife could result from decreasing water availability and associated changes in riparian vegetation within the projected drawdown area. The environmental protection measures that were developed for the Betze Record of Decision are summarized in Section 1.6 of this SEIS. These protection measures established for water resources, riparian habitats, and specific wildlife species have been reflected into the following impact assessments.

Since completion of the Betze Project Draft EIS, an open water conveyance canal has been constructed in Boulder Valley as part of Barrick's water management operations. Linear facilities may present long-term barriers to animal movement, potentially restricting genetic exchange within a population. Environmental protection measures identified by JBR (1995a) and implemented by Barrick to minimize impacts from operation of this 14-mile-long project component include: (1) exclusion fencing along the open-water channel to prevent both large and small mammal access; (2) overpass structures or raised ramps at mile intervals to facilitate animal movements and minimize impacts to genetic exchange within a population; (3) escape structures within the open drainage, in the event individual animals gain access to the channel; and (4) a total of 14 gravity-fed water supply developments for area wildlife use, to enhance existing habitats.

The location and orientation of the water canal would not tend to interfere with the designated mule deer seasonal ranges or generalized migration corridors as shown in Figures 1-4 and 3.4-1. Less prevalent and random mule deer movements could be accommodated by the wildlife crossings provided in its design. The pipeline leading to the open canal bisects pronghorn yearlong and winter range (see Figures 1-4 and 3.4-2), but, because the pipeline is buried, no movement interference should occur. The availability of open water sources adjacent to the canal may increase the distribution of pronghorn over time. The canal would not affect bighorn sheep designated range (see Figure 3.4-3).

The canal would restrict some movements and genetic mixing of certain small mammal and reptile species; however, these potential impacts would be considered minor based on the length of this canal in the project region. Birds, including game birds, would not be impacted by canal placement, but the canal would provide an additional water source during project operation.

### 3.4.2.2 Impacts from Mine Dewatering and Localized Water Management Activities

This section focuses on the potential long-term impacts to terrestrial wildlife species from the drawdown of ground water and the potential for indirect effects to species from reduced surface water availability and a decrease in associated riparian and wetland communities. The potential short- and long-term effects to terrestrial wildlife species from mine water discharges into the Humboldt River and ultimately the Humboldt Sink are addressed in Sections 3.4.2.4 and 3.4.2.5, respectively, of this SEIS.

As discussed in Section 3.2.2.1, a reduction in the ground water levels from mine-induced drawdown could potentially reduce the surface water availability in certain perennial reaches of area streams and naturally occurring springs and seeps, and reduce the associated riparian/ wetland habitats of these sources that are associated with the regional ground water system. It is possible that some springs and other perennial water sources located outside of the 10-foot drawdown contour but within the regional hydrologic study area also could experience changes in flows from ground water drawdown.

Relative to wildlife resources, the following analysis focuses on potential short- and long-term effects to surface water sources, their associated vegetation, and possible use by both resident and migratory wildlife species.

The potential future impacts to surface water resources from Barrick's water management operations are discussed in detail in Section 3.2.2.1. The postmining modeling simulations have identified the extent and timing of drawdown. The general magnitude and extent of drawdown would both directly and indirectly impact wildlife resources. Table 3.2-22 summarizes the springs and seeps that are expected to be affected. These projected future effects would include direct loss of springs and seeps as well as short, isolated perennial stream reaches that are hydraulically connected to the regional ground water system along the western slope of the Tuscarora Mountains. Drawdown from Barrick's water management operations is not expected to affect springs or perennial waters on the eastern slope of the Tuscarora Range. Additional spring sites that are hydraulically connected to the regional ground water also may be impacted, as discussed in Section 3.2.2.1. The maximum extent of these potential effects to surface water availability and the associated riparian communities would occur approximately 100 years after the cessation of mining.

The potential loss or reduction in available surface water could result in long-term changes in wildlife habitats throughout the study area. The habitats associated with naturally occurring springs, seeps, and perennial stream reaches encompass riparian vegetation (both woody and herbaceous plant species), wetland areas (emergents and palustrine), and mesic habitats (moist areas or wet meadows not classified as delineated wetlands that transition into the drier upland communities).

Some impacts or loss of riparian habitats could occur during both the mining and postmining periods. Reduction in subsurface flow could result in effects ranging from decreased plant vigor to the total loss of riparian vegetation cover, depending on a number of hydrological and geological factors (Poff et al. 1997; Scott et al. 1999; Richter et al. 1997). Reduction or loss of riparian habitats associated with these perennial sources would impact terrestrial wildlife dependent on these sources, resulting in a possible reduction or loss of cover, breeding sites, foraging areas, and changes in both plant and animal community structure, as discussed below.

Naturally occurring seeps, springs, and perennial drainages provide important wildlife habitat not otherwise available in the study area. The riparian habitat type and its associated plant communities contribute to a greater wildlife species diversity, compared to the adjacent upland areas. Since surface water and the associated riparian habitat are limiting factors for wildlife in Nevada, the loss of these habitat features would alter the available habitat for species that depend on these riparian areas, resulting in: (1) a reduction of available water for consumption; (2) a reduction in riparian vegetation for breeding, foraging, and cover; (3) reduction in the regional carrying capacity; (4) displacement and loss of animals; (5) a reduction in the overall biological diversity; (6) a potential long-term impact to the population numbers of some species; (7) possible genetic isolation; and (8) reduction in prey availability. The degree of impacts to wildlife resources would depend on a number of variables, such as the existing habitat values and level of use; species' sensitivity (i.e., level of dependency on riparian areas); and the extent of the anticipated water and riparian habitat reductions.

In the event that perennial flows were reduced, the riparian vegetation would likely decrease, reducing the vegetative structure, composition, and diversity. As surface water decreased, herbaceous riparian obligates would be the first to be affected. Continual ground water reduction would result in increasing stresses on riparian-dependent plants, particularly during the late summer and early fall periods. The reduction in ground water levels beneath these perennial water sources would ultimately affect the maintenance and regeneration of woody shrubs and trees, if the ground water levels were to fall below root systems of these plants that are in contact with ground water levels (Scott et al. 1999; Poff et al. 1997; Richter et al. 1997).

Loss or reduction of perennial water sources and associated riparian habitats would reduce the regional carrying capacity for terrestrial wildlife (i.e., the region located within the ground water drawdown area would support a lower diversity and reduced number of riparian-dependent wildlife species). Animals that use perennial water sources would be displaced as the available water and riparian plants declined.

NDOW and the BLM assume that these limited riparian communities are currently at carrying capacity. In other words, the riparian habitat types that typically occur within a desert system support the greatest number of species that is feasible, given the finite resources associated with these communities. Individuals that are displaced may move into adjacent areas, but it is assumed that these adjacent habitat types are already at their full carrying capacity and would not support additional animals. Therefore, these displaced individuals would be lost from the population, concentrating the remaining animals within smaller habitat areas.

Some springs could support genetically isolated populations; therefore, a reduction or loss of springs could result in a loss of genetic diversity and localized populations within the affected area. Possible genetic loss would be limited to less mobile species, such as amphibians.

Species likely impacted by reductions in perennial water sources and associated habitats would include big game, upland game birds, waterfowl, nongame birds (e.g., raptors, passerines), mammals (e.g., bats), reptiles, amphibians, and fish. The extent of these indirect effects from the mine's dewatering activities would depend on the species' use and relative species' sensitivity, as discussed for each group below.

### Big Game

Big game species require water during the summer and fall periods (March 16 to November 15), as well as during the winter period, as needed, to satisfy physiological requirements. The reduction or loss of existing water sources could impact big game use and movements. Figure 3.4-1 depicts the possible loss of perennial surface water that could occur within mule deer summer range in the northern portion of the Tuscarora Mountains. However, the greatest impacts to mule deer would be a reduction or loss of available water on important transitional ranges along the Tuscarora Mountains and the upper Boulder Creek area. The loss or reduction of available water in these areas would force deer into adjacent areas that are already impacted by mining operations along the Carlin Trend. It is assumed that some deer would be lost from the population; however, this loss cannot be quantified.

Pronghorn ranges that may be affected by the loss or reduction of perennial water sources would encompass portions of summer range along the upper portions of Antelope Creek. A small portion of pronghorn transitional range also could be impacted in upper Boulder Valley (see Figure 3.4-2). As discussed for mule deer, the effects to available water within pronghorn summer range would incrementally reduce the range's carrying capacity, displacing animals into adjacent ranges that may not support additional herd numbers.

Only a small portion of bighorn sheep yearlong range occurs within the drawdown area; however, this range is not intersected by areas where perennial waters could be affected by ground water drawdown (see Figure 3.4-3). Given the ground water analysis, no impacts to bighorn yearlong range would be expected.

### Upland Game Birds

A reduction in the riparian community would ultimately affect the amount of nesting habitat for mourning doves and both potential brooding and foraging habitat for doves, sage grouse, and chukar. A decline in surface water availability would impact the extent of open water and riparian vegetation along perennial streams. This incremental habitat loss would be long term, and it is assumed that the birds that are closely associated with these riparian areas would be displaced. However, since riparian communities are limited within the study area, it cannot be assumed that displaced individuals would successfully relocate into adequate breeding or foraging habitat in adjacent areas. As discussed above, it is likely that these adjacent habitats would be at carrying capacity and these breeding birds could be lost from the population. A reduction in riparian vegetation also could be a limiting factor in brood rearing during the later summer when food sources, such as upland forbs, may decline due to dry conditions. The estimated acreage of riparian or wetland habitat types located within areas that could be affected by a possible reduction in surface water and vegetation associated with spring, seep, or riparian areas is approximately 150 acres. The percentage of these areas that may be used by upland game birds cannot be estimated; in addition, the potential impacts to mesic habitat and the potential loss of individuals cannot be quantified. Potential effects to sage grouse are discussed further in Section 3.6.

### Waterfowl and Shorebirds

Short- and long-term effects to waterfowl and shorebird species that may be present within the study area would vary, depending on the vegetative structure and habitat types associated with springs that may support nesting, foraging, or resting birds. As discussed in Sections 3.4.1.2 and 3.4.1.3, waterfowl and shorebird numbers in the water management area were not historically high. The increased incidence of use and number of birds recently recorded in Boulder Valley were based on the increased surface water availability in the vicinity of the TS Ranch Reservoir. These areas of open water resulted in artificially high numbers of waterfowl and shorebirds beginning in the early 1990s. These numbers declined in correlation with the reduced surface and subsurface flows at TS Ranch Reservoir; at the Green, Knob, and Sand Dune spring sites; and along the irrigation canal located south of these springs. The number of waterfowl and shorebird species using these habitats fluctuates according to the changing water levels (see Section 3.4.1.2).

The long-term impacts to waterfowl or shorebird species commonly associated with the water management area would encompass two separate issues. The artificially created wetlands in Boulder Valley have supported a large number and diversity of waterfowl and shorebirds over the last decade. As the mine discharges diminish in the future, the level of free water that has surfaced within the valley, in addition to the associated riparian and wetland vegetation, would be reduced as well. It is anticipated that the number and species of water birds that use these artificial wetland communities would decline, particularly as the drier, more upland habitats began to re-establish in the Valley. However, based on current anecdotal observations of the soils and vegetation in this area, it appears that the saturated soils are increasing the leaching of minerals and salts into the soil surface and subsurface layers, thereby modifying the associated plant communities. This transition to a vegetative community of more salt-tolerant species would result in a changing wildlife community as well.

The other primary issue would be the water birds associated with the larger, natural spring sites in the foothill regions of the study area, the perennial portions of streams that support adequate riparian habitat and pools for foraging and cover that occur within the drawdown area, and any areas that may experience effects to surface water outside the 10-foot drawdown contour. The long-term reduction or loss of available surface water and associated emergent plants in these naturally occurring wetland areas currently used by water birds would result in the displacement or loss of these birds. As discussed for other wildlife species, it is assumed that the riparian communities potentially affected by the mine's dewatering activities are currently at their respective carrying capacities, given their limited availability in the study area. Therefore, loss of surface water and the associated riparian vegetation at historically occupied wetland areas would result in the displacement and/or loss of the individual birds that are dependent on these resources. This loss may affect the breeding potential of certain species.

In summary, isolated birds and breeding pairs may be impacted by the long-term reduction or loss of surface water and riparian or emergent habitat types, possibly affecting the population viability of certain species; however, the extent of this impact cannot be quantified. It is assumed that the ultimate reduction in bird numbers associated with the artificially created wetlands in Boulder Valley to the premining levels (i.e., once mine dewatering has ceased) would not result in population-level impacts. Potential effects to waterfowl and shorebirds from long-term changes along the Humboldt River and into the Humboldt Sink are discussed in Sections 3.4.2.4 and 3.4.2.5, respectively.

### Raptors

As discussed in Section 3.4.1.3, a variety of raptor species may breed, migrate, forage, or roost in or near the study area, including along the Humboldt River corridor and in the Humboldt Sink. The impact analysis focused on the potential short- and long-term impacts to habitats utilized by raptors that could be affected by the ground water drawdown. Possible short- and long-term effects to raptors from ongoing and future mine water discharges into the Humboldt River and the Humboldt WMA are discussed in Sections 3.4.2.4 and 3.4.2.5, respectively.

Potential long-term impacts to raptor species could include loss of potential nesting, roosting, and foraging habitat along the perennial drainages and at the seeps and springs identified in Section 3.2.2 within the drawdown area shown in Figure 3.2-21. These losses would result from an incremental reduction in available habitat for both resident and migratory raptor species. In addition, the regional carrying capacity would be reduced by two factors. The most important factor would be the reduction in the prey base. The availability of riparian-dependent prey species for raptors would be reduced within the area potentially affected by drawdown (see Figure 3.2-21), possibly forcing birds to forage more within the upland habitats, which are not as diverse as the riparian communities. This anticipated loss of prey is not quantifiable. The second factor associated with the carrying capacity for raptors would be the incremental loss of available nest and roost sites. Some raptor species (e.g., red-tailed hawk, Swainson's hawk, Cooper's hawk, sharp-shinned hawk, American kestrel) are closely associated with riparian habitats large enough to support trees and increased shrub density. Other species (e.g., golden eagle, prairie falcon, rough-legged hawk) may use these trees for roosting only, but the drawdown area has limited vertical diversity in plant structure. Therefore, these roost sites are important, particularly for hunting activities. Potential impacts to special status raptor species are discussed in Section 3.6.

#### Songbirds

The potential short- and long-term effects to both resident and migratory songbird species (including neotropical migrants) from ground water drawdown would parallel those discussed for upland game birds and nongame raptor species. Those songbirds that generally depend on open water and riparian habitats for breeding, foraging, or resting during migration would be the most affected. The incremental loss of riparian or emergent habitats would result in bird displacement and possible reduction in local avian population numbers. Breeding birds could be lost from the population, assuming that the regional carrying capacity would not support riparian-dependent birds moving into adjacent habitats. Migrant songbirds also may be displaced. The additional energy required for individuals to find suitable resting or foraging habitat may compromise some birds' survival during migration. The potential for population-level impacts to occur from ground water drawdown would depend on the relative species' sensitivity, rarity, and habitat associations. The Migratory Bird Treat Act protects migratory birds from direct loss of nest sites, individuals, eggs, or young; however, the Act does not protect potential habitat for avian species. Loss of an active nest site, eggs, young, or adult birds from changes in water availability would be in violation of the Act, whereas the potential for long-term loss of potential habitat from ground water drawdown would not.

#### Amphibians and Reptiles

Potential impacts to amphibian and reptile species that are associated with the perennial water sources that may be affected by Barrick's ground water drawdown activities would parallel those discussed for other terrestrial wildlife species. The loss or reduction in surface water availability and associated riparian vegetation would result in an incremental loss of suitable breeding, foraging, and cover habitats for these species that depend on these areas. Some springs could support genetically isolated populations of certain amphibian species. A reduction or loss of spring sites could, therefore, result in a loss of genetic diversity and localized populations within the projected drawdown area. Population level effects to either amphibian or reptile species could occur in the long term, depending on the extent of the surface effects from ground water drawdown and the relative sensitivity of the species affected.

#### Summary

As discussed above, the existing environmental protection measures to which Barrick has committed are summarized in Section 1.6 of this SEIS. The implementation of these measures would partially mitigate the anticipated impacts to terrestrial wildlife resources from future effects to perennial water sources and associated riparian habitats in the long term. These measures would aid in offsetting impacts to species from the loss or reduction of available water, riparian or wetland communities, and forage or prey availability. However, the measures would not completely mitigate these anticipated impacts to terrestrial wildlife as discussed in Section 3.4.4.

### 3.4.2.3 Impacts Associated with the Pit Lake

Aquatic communities could eventually develop in the pit lake(s). Algae would likely develop in the lake and thus act as a food source for primary consumers, such as zooplankton and other pelagic invertebrates. Once the pit lake water level stabilizes, vascular plants and associated benthic macroinvertebrate populations could become established; however, populations should remain relatively low and should not represent a substantial food source for avian or mammalian wildlife.

The distance from the rim of the excavated mine pit to the bottom of the pit would be approximately 1,000 feet following cessation of mining, and the rim-to-lake-surface distance would still be over 100 feet when the lake is full. This distance, combined with the precipitous nature of the pit walls, would substantially restrict access to the lake by terrestrial organisms, although aerial species (e.g., bats and birds) would be able to reach the lake's surface. Therefore, certain wildlife species may be able to use the pit lake as a drinking water source.

To determine if concentrations of metals in the pit lake might pose a risk to birds or mammals consuming the water, median pit lake concentrations were compared to benchmark values from Sample et al. (1996). These benchmark values represent No Observed Adverse Effect Levels (NOAELs) for the ingestion of water. Animals ingesting water with less than or equal to these metal concentrations should not experience adverse effects. The NOAELs were determined experimentally through laboratory studies with test organisms (e.g., rat, mouse, mallard) and then converted (using appropriate equations) for application to wildlife species. For this simple comparison, three species were selected: the rough-winged swallow, red-tailed hawk, and little brown bat. These species may not necessarily be found at the pit lake but are surrogates for organisms that may be found in the pit lake area and may ingest pit lake water (e.g., cliff swallow). All of the benchmark values for these three species exceeded the highest (during any stage of lake filling) median concentration found in the pit lakes (see Table 3.4-1). Based on this comparison, the pit lake water metal concentrations, both in the two early pit lakes and in the final combined pit lake, should not be high enough to cause adverse effects to either mammalian or avian species that consume lake water.

Although median pHs of both the east and west pit lakes are predicted to be slightly alkaline, there is a potential for acidic (pH approximately 5 to 6) conditions up to year 26. Research has found that very acidic (pH less than 4) conditions can cause acute effects to waterfowl (Stubblefield et al. 1997; Foster and Ramsdell 1997). The pH of the pit lakes should be higher than 4.0 and therefore should not pose a significant acute risk to wildlife, although the possibility of chronic effects (e.g., reduced growth and reproduction) may exist. However, no studies have been conducted on the chronic effects of long-term exposure to low-pH water. There should be no risk from low-pH water after 26 years.

### 3.4.2.4 Impacts to the Humboldt River

As part of the terrestrial wildlife assessment, it is important to note that overall species diversity and habitat characteristics along the Humboldt River have been influenced by past settlement patterns, man-induced channelization projects, and current land uses. These activities historically have altered the overall landscape, vegetative composition, biological character, and wildlife species along the Humboldt River system (see Section 3.4.1.1). The Humboldt River is classified as perennial; however, as with many river systems throughout the arid, western United States, certain reaches are often dry during the late summer and early fall. The extent and distribution of riparian vegetation along the river are determined by seasonal variations, including water scouring during high-flow periods and water availability during low-flow periods (i.e., baseflow).

Increased flows in the Humboldt River from the mine's potential discharges would result in a net increase in available water for terrestrial wildlife, including mule deer, waterfowl, shorebirds, songbirds, raptors, beaver, river otter, and other terrestrial species that are closely associated with these river communities (see Section 3.2.2.2). Increased flows may better support existing plant communities of willow, wild rose, cottonwoods, and emergent vegetation (e.g., bulrush, cattails) immediately adjacent to the river channel, particularly during the low-flow periods (October through February). Increased riparian vegetation would be site-specific, depending on the existing

### Table 3.4-1
### Highest (from 10 to 233 years) Median Pit Lake Water Concentrations and Benchmark NOAELs[1] for Water Ingestion

| Chemical | Highest Concentration (mg/L) | Year/Location | Water Ingestion NOAELs (mg/L) | | |
|---|---|---|---|---|---|
| | | | Rough-winged Swallow | Red-tailed Hawk | Little Brown Bat |
| Aluminum | <0.021 | All[2] | 471.4 | 1,930.0 | 8.188 |
| Antimony | 0.066 | Yr 26; east lake | | | 1.105 |
| Boron | 0.009 | Yr 233; combined pit lake | 124 | 507 | 457 |
| Cadmium | <0.0024 | All | 6.23 | 25.51 | 15.757 |
| Copper | <0.003 | All | 202.0 | 826.9 | 248.5 |
| Fluoride | 1.72 | Yr 233; combined pit lake | 33.5 | 137.2 | 666.2 |
| Manganese | <0.002 | All | 4,284 | 17,541 | 1,438 |
| Nickel | <0.017 | All | 332.61 | 1,361.76 | 653.42 |
| Selenium | 0.006 | Yr 10; west pit lake | 2.149 | 8.797 | 3.267 |
| Strontium | 0.185 | Yr 26; west pit lake | | | 4,296 |
| Thallium | 0.001 | All | | | 0.122 |
| Zinc | <0.002 | All | 62.3 | 255.1 | 2,613.7 |

[1] Benchmark NOAELs are from Sample et al. 1996.
[2] “All” indicates the predicted concentration is the same in all pit lake configurations and years after mine closure.

condition or health of the plant species present, channel geometry and stability, livestock grazing intensity and season of use, and timing of increased flows. Additional water levels along existing river meanders and old oxbows that currently do not receive sufficient water during the high-flow periods (April through June) could help to establish on-channel ponds and support valuable riparian or emergent vegetation. These backwater areas provide important nesting, brooding, foraging, and resting habitat for many terrestrial wildlife species. Conversely, the greater depths and flows could reduce the potential for some isolated pools and natural sloughs to occur in the river during low-flow conditions, limiting the use by breeding or foraging individuals in these areas.

Increased flows also would aid in maintaining wet hay meadows immediately adjacent to the river channel. These meadows provide marsh-like habitat for terrestrial wildlife, which is of greater value than the drier, upland meadows that are dominated by annual grasses. These wet meadows are second highest in avian diversity (as compared to the willow community), particularly when interspersed with either willow or buffaloberry stands.

Increased water availability from mine dewatering discharges may aid in restoring wetland and marsh habitats (e.g., the Herrin Slough). The Herrin Slough is a valuable area for wildlife located within the Humboldt River floodplain upstream of the Comus Gage. Slightly increased water levels in the river would help maintain moisture in the low-gradient network of side channels that provides high quality habitat for a number of important species (e.g., great blue heron, snowy egret, Virginia rail, gadwall, black-headed grosbeak, lazuli bunting). Maintenance of this river segment is particularly important, since it is likely one of the few reaches that is capable of supporting species that require dense cover, such as mountain lions.

No impacts to terrestrial wildlife from increased water levels in Rye Patch Reservoir would be anticipated, based on the limited extent of shallow, littoral habitats that currently exist along the reservoir shoreline. Increased water levels within the Pitt-Taylor Reservoirs may reduce certain areas of shallow-water habitats for waterfowl and shorebird species, as the increased depth would limit plant productivity and food production in those locations. However, as stated in Section 3.3.2.2, it also is assumed that additional areas that are temporarily inundated with increased flows may produce additional foraging habitat, as emergent and aquatic plants become established.

Increased water in the river channel downstream of Rye Patch Reservoir may be valuable for terrestrial wildlife resources, since many of the native riverine habitats that historically occurred along this river reach have been compromised by past agricultural practices, increased channelization, and tamarisk invasion. Although portions of this reach still maintain high quality habitat and increased species diversity, increased river flows could help improve habitat values in degraded areas.

The Humboldt River's channel sinuosity varies greatly from human-induced changes (e.g., channelization) along the river corridor, thereby affecting the overall habitat values, species diversity, biodiversity, and species density. Limited additional flooding immediately adjacent to the Humboldt River could occur during high-water periods (see Section 3.2.2.2). The potential effects to terrestrial wildlife resources from this flooding would include potential loss of site-specific nesting or feeding sites for certain wildlife species (e.g., waterfowl, shorebirds); however the level of these possible impacts would be expected to be low (see Section 3.2.2.2). Increased yearlong flows would remove some channel habitat along the river corridor that currently provides nesting and foraging habitat. However, additional habitat also could be created in other backwater areas.

Maintaining existing willow stands and enhancing conditions to establish additional willow along the river by increased water flow would improve habitat for a wide diversity of wildlife species. Willows provide both vertical and horizontal structure for breeding sites, escape cover, thermal cover, and bank stability and support the greatest wildlife species diversity along the Humboldt River. Willows are a primary successional species that aid in building and maintaining river floodplains, which are considered high quality wildlife habitat, particularly if mid- and understory species (e.g., wild rose, currant, bulrush, rushes, sedges, meadow grasses) can be maintained.

As described in Section 3.2.2.2, increased water levels during the mine dewatering discharges would be most apparent during the fall and winter (October through February), which is typically the river's low-flow period. These increased flows could result in more open water during low-flow months. Some river reaches that typically freeze because of low-water conditions may remain open from the increased flows. This open water could provide additional foraging areas for wildlife species that commonly feed along the river during the winter, such as wintering bald eagles (see Section 3.6). The effects to the river during the peak flows (April through June) would be less apparent. As compared to the natural flows during this period, the increased water in the channel would be a relatively small change.

In summary, higher flows in the Humboldt River system would likely result in improved maintenance and establishment of riparian vegetation, increased areas of open water during the winter, and improved water quality for both aquatic and terrestrial species during the period of the mine's discharges. These potential effects likely would apply more to birds than other wildlife groups, based on the incidence of avian use (52 percent exclusively associated with the riparian habitat type), the fact that water and its associated habitats are the most limiting factor in northern Nevada, and NDOW survey results from the Humboldt River studies (Bradley 1992; Neel 1994; Bradley and Neel 1990).

#### 3.4.2.5 Impacts to the Humboldt Sink

The impact analysis for terrestrial wildlife associated with the Humboldt Sink focused on the effects from increased water quantity and the potential increase in concentrations of inorganic constituents in the sink. This analysis delineates the differences between the concentration and the increased loading of specific constituents of concern. Because the Humboldt Sink is the closed-basin terminus of the Humboldt River, encompasses the Humboldt WMA (one of the most important wildlife areas in Nevada), and is a primary stopover for waterfowl along the Pacific Flyway, the potential for adverse long-term impacts is a primary concern.

Impacts from increased flows and associated water levels in the Humboldt Sink would parallel those discussed for the Humboldt River. Although this dynamic wetland system is characterized by both wet and dry cycles, additional water flowing into the Humboldt Sink and possibly the Carson Sink would provide increased water for wildlife resources.

Appendix E provides a summary of waterfowl use recorded in the Humboldt WMA, Stillwater WMA, and Carson Lake over the last 30 years (Saake 1998). Impacts from increased water availability would include improved nesting, foraging, and resting opportunities for both resident and migratory waterfowl and shorebird species. In turn, the increase in water availability for these species would increase the relative prey availability for area predators.

Some areas of wetland vegetation within the Humboldt Sink may be flooded with higher water levels, resulting in a temporary loss of potential forage plants and cover for birds. However, emergent wetland vegetation would re-establish along the margins of the sink, resulting in a net increase in the amount of wetland vegetation available for wildlife during the discharge period. Following cessation of Barrick's water management operations, conditions at the Humboldt Sink would eventually return to pre-discharge levels.

The USFWS and USGS have conducted studies on the water quality of the Humboldt Sink, as discussed in Section 3.2.1.3. The purpose of these studies was to determine whether the water quality associated with the Humboldt Sink, and specifically the Humboldt WMA, could adversely affect both terrestrial and aquatic wildlife resources, particularly from the irrigation return water flowing into Toulon Lake and Humboldt Lake.

### Premining Risks to Wildlife

Because the Humboldt Sink is a terminal wetland with no outflow, concentrations of ions, including trace metals, must naturally increase in some media in the sink unless removed via wind erosion or catastrophic flooding. Materials entering into the sink may be in the dissolved or suspended form. Suspended materials are likely to settle to the sediment, although they may become resuspended during periods of high wind. Dissolved materials also may eventually precipitate out of solution through complexation and ion interactions that often occur in solutions with higher ionic strengths. Some materials may bioaccumulate in local animal and plants that occupy the Humboldt Sink. Because large numbers of wildlife species are attracted to the sink and depend on its food resources, these species also are exposed to elements and compounds that have accumulated at the sink.

To determine the potential risk to wildlife utilizing the Humboldt Sink prior to Barrick's discharges into the Humboldt River, two methods were employed. First, water concentrations and organism tissue concentrations measured in the sink were compared to concentrations that have been found to potentially cause adverse effects to organisms through water and food ingestion in laboratory and field investigations. Second, to determine the potential cumulative effects of ingesting materials through all routes of exposure (water, food, sediment), a dose to selected receptor organisms was calculated for several chemicals of concern.

Evaluations of risk are often difficult because empirical data are often lacking. Fortunately, the USGS and USFWS have collected information on water, sediment, and tissue concentrations of several constituents for several years near and upstream of the Humboldt Sink (Seiler et al. 1993; Seiler and Tuttle 1997). These data were used in the evaluations presented here. Because the purpose of these evaluations was to examine potential effects prior to mining activity, only data collected prior to November 1990 were used. Also, only data collected from Humboldt Lake were used. Much of the water flowing into

Humboldt Lake has passed through an extensive agricultural diversion system upstream of the lake. Water chemistry in Humboldt Lake is, therefore, reflective of the influence of these diversions and more representative of water in the WMA than is water upstream of the diversions.

### Screening Against Literature-Based Concentrations

Mean concentrations of several constituents were calculated with Humboldt Lake data collected from 1990, or earlier (Table 3.4-2). The mean values were then compared to concentrations found in the literature from toxicity studies of that particular constituent. Both water-borne and tissue concentrations were evaluated. Water concentrations were screened against those studies where organisms were exposed via water only. Tissue concentrations were screened against studies where the route of exposure to the test organisms was through the diet, that is, food ingestion. This was deemed appropriate since the organisms for which tissue levels were measured in the USGS/USFWS studies (i.e., aquatic insects, aquatic plants, waterfowl, and fish) are food items for higher-level consumers in the wetland. Screening values were No Observed Adverse Effect Levels, or NOAELs, (highest concentrations that had no significant effects) and Lowest Observed Adverse Effect Levels, or LOAELs, (lowest concentrations that did have significant effects). For some of the constituents there were no studies where the chemical was introduced through water, therefore, only dietary screening was used.

All of the mean water concentrations from Humboldt Lake were well below the NOAEL or LOAEL found in the literature (Table 3.4-3). Tissue concentrations of boron, selenium, and mercury exceeded one or more threshold values (Table 3.4-4). These data suggest that, under premining conditions, some metals could have been in high enough concentrations in the Humboldt Sink to cause adverse chronic effects to wildlife utilizing the sink.

### Effects through Food, Sediment, and Water Ingestion

Since initial screening of the chemicals of concern in the Humboldt Sink indicated that some wildlife species could be at risk, a further analysis was undertaken to evaluate the effects of ingesting materials from all possible routes of exposure. Four receptor species, mule deer, great blue heron, mallard duck, and bald eagle, were selected for this evaluation. These species represent organisms that may be found in the Humboldt Sink on a long-term or short-term basis. They are not meant to represent all of the species found at the sink; although they do represent a range of life strategies. Mule deer and the bald eagle are the less frequent visitors, passing through the area on occasion rather than being permanent residents.

For each of the receptor species, the possible routes of exposure were identified. Those routes were:

- Mule deer – water ingestion only
- Great blue heron – water ingestion and fish consumption
- Mallard duck – water ingestion and consumption of aquatic macrophytes (24.7 percent of diet), invertebrates (72 percent of diet), and incidental sediment (3.3 percent of diet)
- Bald eagle – water ingestion and consumption of fish (58 percent) and waterfowl (14 percent); remainder of diet is assumed to be mammals

Factors used to estimate ingestion included body weight and food and water ingestion rates. These factors were all derived from the literature or calculated using USEPA equations (USEPA 1993). If necessary, food ingestion rates were adjusted to a dry weight basis, rather than a wet weight basis.

By combining the amount of a chemical that theoretically might be received by a receptor organism via the different sources, a total daily dose is calculated. For this evaluation, two sets of dose calculations were made; one using mean water, sediment, and tissue (premining)

## Table 3.4-2
## Surface Water, Sediment, and Tissue Concentrations of Constituents of Concern from Humboldt Lake (1987-1990)

| Date of Sample | As | B | Cr | Cu | Li | Hg | Mo | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|
| Surface Water Concentration (µg/L) | | | | | | | | | |
| 10/7/87 | 210 | 3900 | <10 | <10 | 660 | 0.2 | 31 | 2 | 10 |
| 3/17/88 | 56 | 3500 | <1 | <1 | 560 | <0.1 | 27 | <1 | 20 |
| 8/24/88 | 90 | 4300 | <1 | -- | 700 | <0.1 | 38 | <1 | 10 |
| 3/28/89 | 98 | 5400 | <1 | -- | 710 | <0.1 | 44 | <1 | 10 |
| 3/26/90 | 78 | 4500 | 1 | 2 | -- | <0.1 | 26 | <1 | <10 |
| 7/9/90 | 59 | 2700 | 2 | 1 | -- | 0.2 | 24 | 1 | <10 |
| 11/26/90 | 76 | 3800 | <1 | 2 | -- | <0.1 | 19 | <1 | <10 |
| **Mean** | **95** | **4014** | **1.4** | **2.1** | **658** | **0.09** | **30** | **0.8** | **9** |
| Sediment Concentrations (µg/g dry weight) | | | | | | | | | |
| 11/26/90 (<2 mm) | 20 | 21 | 17 | 16 | 45 | 0.02 | 4 | 1.1 | 43 |
| 11/26/90 (<62 µm) | 21 | 10 | 19 | 17 | 46 | 0.08 | 5 | 1.4 | 46 |
| Mean | 20.5 | 15.5 | 18 | 16.5 | 45.5 | 0.05 | 4.5 | 1.25 | 44.5 |
| Invertebrate (Diptera and Hemiptera) Concentrations (µg/g dry weight) | | | | | | | | | |
| 6/15/90 | 14 | 44 | 4 | 20 | -- | 0.10 | <1 | 5.0 | 58 |
| 6/15/90 | 4.7 | 29 | 5 | 16 | -- | 0.15 | <2 | 2.6 | 73 |
| 8/5/86 | 7.6 | <46 | 20 | 26 | -- | <0.44 | <0.93 | 2.5 | -- |
| 8/5/86 | 0.87 | <27 | <1.6 | 26 | -- | 0.33 | 1.7 | 5.1 | 170 |
| 6/15/90 | 3.0 | 29 | <1 | 33 | -- | 0.10 | 1 | 4.6 | 163 |
| **Mean** | **6.0** | **28** | **6.1** | **24** | **--** | **0.18** | **0.93** | **4.0** | **116** |
| Plant (*Potamogeton*) Concentrations (µg/g dry weight)[1] | | | | | | | | | |
| 6/15/90 | 14 | 620 | 1 | 6 | -- | 0.03 | 3.1 | 0.5 | 15 |
| Whole Fish (carp) Concentrations (µg/g dry weight) | | | | | | | | | |
| 10/29/86 | 0.81 | <27 | 6.8 | 2.6 | -- | 0.46 | 50 | 3.9 | 110 |
| 10/29/86 | 0.96 | <23 | 6.3 | 1.8 | -- | 0.72 | <1 | 1.9 | 120 |
| 10/29/86 | 1.2 | <26 | 6.4 | 3.8 | -- | 0.54 | <1 | 2.4 | 100 |
| **Mean** | **0.99** | **12.7** | **6.5** | **2.7** | **--** | **0.57** | **17** | **2.7** | **110** |
| Bird Liver (mallard, American coot, black-necked stilt) Concentrations (µg/g dry weight) | | | | | | | | | |
| Mallard | | | | | | | | | |
| 7/23/88 | 0.38 | ¾ | 0.62 | 93 | -- | 0.34 | <7 | 7.2 | 171 |
| 7/23/88 | 0.40 | 2.7 | 0.60 | 175 | -- | 0.49 | <7 | 7.4 | 205 |
| 7/23/88 | 0.47 | 3.9 | 0.63 | 189 | -- | 0.35 | 9 | 9.8 | 198 |
| 7/23/88 | <0.30 | 3.1 | <0.50 | 117 | -- | 0.27 | <7 | 8.8 | 188 |
| 8/9/88 | 0.36 | 9 | <2 | 16 | -- | 0.70 | 3.8 | 23 | 164 |
| 8/9/88 | 0.10 | 10 | <2 | 46 | -- | 0.71 | 2 | 13 | 167 |
| 8/9/88 | 0.20 | 9 | <2 | 12 | -- | 0.59 | 3 | 20 | 135 |

## Table 3.4.2 (Continued)
## Surface Water, Sediment, and Tissue Concentrations of Constituents of Concern from Humboldt Lake (1987-1990)

| Date of Sample | As | B | Cr | Cu | Li | Hg | Mo | Se | Zn |
|---|---|---|---|---|---|---|---|---|---|
| American Coot | | | | | | | | | |
| 8/9/88 | 0.30 | 5 | <2 | 13 | -- | 1.5 | 4 | 8.7 | 93 |
| 8/9/88 | 0.52 | 8 | <2 | 26 | -- | 0.44 | 4.7 | 9.1 | 96 |
| 8/9/88 | 0.20 | 5 | <2 | 28 | -- | 0.42 | | 11 | 121 |
| 8/9/88 | 0.20 | 5 | <2 | 27 | -- | 3.2 | 4.3 | 13 | 137 |
| 8/9/88 | 0.41 | 4 | <2 | 35 | -- | 0.42 | 6 | 11 | 118 |
| 8/9/88 | 0.20 | 3 | <2 | 33 | -- | 0.27 | 4.3 | 11 | 111 |
| 8/9/88 | 0.20 | 4 | <2 | 32 | -- | 0.27 | 3 | 8.5 | 111 |
| 8/9/88 | 0.28 | 6 | <2 | 18 | -- | 0.31 | 4.6 | 8.8 | 98 |
| 8/9/88 | 0.50 | 3 | <2 | 13 | -- | 0.42 | 4 | 9.8 | 88 |
| 8/9/88 | 0.30 | <2 | <2 | 26 | -- | 0.41 | 4 | 12 | 132 |
| 8/9/99 | 0.38 | 5 | <2 | 17 | -- | 0.62 | 5.6 | 7.8 | 144 |
| 8/9/88 | 0.36 | 5 | <2 | 15 | -- | 0.21 | 3 | 10 | 81 |
| 8/4/86 | 0.36 | 11 | <1.3 | 63 | -- | 0.41 | 5.5 | 15 | 220 |
| 8/4/86 | 0.39 | 39 | <1.2 | 29 | -- | 0.75 | 3.4 | 9.3 | 170 |
| 8/4/86 | 0.40 | 73 | <1.1 | 80 | -- | 0.35 | 4.4 | 11 | 240 |
| 8/4/86 | 0.65 | 47 | <1.3 | 77 | -- | 0.68 | 3.9 | 12 | 220 |
| 8/4/86 | 0.36 | 51 | <1.2 | 110 | -- | 0.53 | 4.5 | 9.0 | 200 |
| Black-Necked Stilt | | | | | | | | | |
| 8/4/86 | <0.17 | 24 | <1.1 | 18 | -- | 4.4 | 2.5 | 34 | 110 |
| 8/4/86 | <0.18 | 25 | 1.4 | 18 | -- | 0.51 | 2.1 | 31 | 98 |
| 8/4/86 | <0.17 | 190 | 1.9 | 17 | -- | 0.44 | 2.1 | 29 | 81 |
| 8/4/86 | <0.18 | 110 | 1.4 | 18 | -- | 0.61 | 2.3 | 42 | 120 |
| 8/4/86 | <0.17 | 45 | 2.6 | 19 | -- | 0.38 | 1.7 | 29 | 82 |
| 7/30/87 | <0.20 | 2 | <1 | 22 | -- | 2.5 | 2 | 11 | 100 |
| 7/30/87 | <0.20 | <2 | <1 | 24 | -- | 2.4 | 2 | 31 | 97 |
| 7/30/87 | <0.20 | <2 | <1 | 16 | -- | 1.9 | 2 | 48 | 86 |
| 8/12/87 | <0.20 | <2 | <1 | 23 | -- | 2.1 | 2 | 32 | 88 |
| 8/12/87 | <0.20 | <2 | <1 | 33 | -- | 2.4 | 3 | 23 | 94 |
| **Mean** | **0.27** | **21.1** | **0.90** | **44** | | **0.95** | **3.62** | **16.95** | **134.24** |

Source: Seiler et al. 1993.

[1] Only one premining *Potamogeton* sample was collected from Humboldt Lake.

Note: One-half the detection limit was used to calculated means when the concentration was less than detection.

### Table 3.4-3
### Mean Surface Water Concentrations Measured in Humboldt Lake and Threshold Effects Levels from the Literature[1]

| Constituent | Concentration (mg/L) | Threshold Value (mg/L) | Notes/Source[2] |
|---|---|---|---|
| Arsenic | 0.095 | 5 | LOAEL, rat reproduction (Schroeder and Mitchener 1971) |
| Mercury | 0.00009 | 100 | NOAEL, chicken reproduction (Scott et al. 1975) |
| | | 5 | NOAEL, mouse lifespan (Schroeder and Mitchener 1975) |
| Molybdenum | 0.03 | 10 | LOAEL, mouse reproduction (Schroeder and Mitchener 1971) |
| Selenium | 0.0008 | 1.5 | NOAEL, rat reproduction (Rosenfeld and Beath 1954) |
| | | 0.002 | Suggested hazardous concentration in water (Lemly 1993) |

[1] Water concentrations from Seiler et al. 1993.

[2] LOAEL = Lowest Observed Adverse Effect Level; NOAEL = No Observed Adverse Effect Level.

### Table 3.4-4
### Mean Tissue Concentrations Measured in Organisms Collected in Humboldt Lake and Threshold Effects Levels from the Literature[1]

| Tissue/Organism | Constituent | Concentration (µg/g) | Threshold Value (µg/g)[2] | Notes/Source[3] |
|---|---|---|---|---|
| Plant (*Potamogeton*) | Arsenic | 14 | 30 | LOAEL, growth in female mallards (Camardese et al. 1990) |
| Plant (*Potamogeton*) | Boron | 620 | 288 | NOAEL, mallard reproduction (Smith and Anders 1989) |
| | | | 10 | LOAEL, growth in female mallards (Hoffman et al. 1990) |
| Fish (carp) | Mercury | 0.57 | 0.5 | LOAEL, mallard reproduction (Heinz 1979) |
| Bird Livers (mallard, American coot, black-necked stilt) | Mercury | 0.95 | | |
| Fish (carp) | Molybdenum | 17 | 500 | LOAEL, chicken reproduction (Lepore and Miller 1965) |
| | | | 200 | LOAEL, growth in chickens (Arthur et al. 1958) |
| Invertebrate (Diptera & Hemiptera) | Selenium | 4.0 | 5 | NOAEL, mallard reproduction (Heinz et al. 1987) |
| | | | 2.9 | LOAEL, avian reproduction (USDI 1998) |
| Bird Livers (mallard, American coot, black-necked stilt) | Selenium | 16.95 | 3.53 | NOAEL, screech owl reproduction (Wiemeyer and Hoffman 1996) |

[1] Tissue concentrations from Seiler et al. 1993.

[2] Threshold values are dry weight, or as given in report/article if wet or dry weight was not specified.

[3] LOAEL = Lowest Observed Adverse Effect Level; NOAEL = No Observed Adverse Effect Level.

concentrations and another using maximum (premining) concentrations. The calculated dose of a constituent for each species was compared to the NOAEL that was derived from laboratory toxicity studies found in the literature. Since water and dietary intake were combined in this evaluation, the lowest NOAEL found in the literature was used, regardless of whether exposure in the toxicity studies was through water or diet. In the toxicity studies from which the NOAELs were developed, test organisms were generally the common species used in mammalian or avian studies (e.g., mouse, rat, chicken, mallard). If only a LOAEL was provided for a given study (i.e., the lowest test concentration that caused a significant effect), a NOAEL was calculated by dividing the LOAEL by 10. Because toxicity threshold levels may vary with body size in mammals, mammalian NOAELs were adjusted for each of the receptor species according to body weight (Sample et al. 1996). Avian NOAELs were not adjusted. Laboratory-derived NOAELs (prior to body-weight adjustments) are given in Table 3.4-5. Hazard quotients were calculated by dividing the calculated dose by the NOAEL. Hazard quotients greater than 1 mean that the theoretical dose of a constituent exceeds the dose found, in laboratory toxicity studies, to cause no significant chronic (long-term) effects. Hazard quotients greater than 1 do not necessarily indicate that adverse effects do/will occur, but do indicate that the chemical of concern could pose a risk to wildlife and further investigation could be warranted. When either the mean or maximum concentrations in water, sediment, and tissue are used in this evaluation of premining conditions, none of the hazard quotients exceeded 1.

These evaluations indicate that some constituents in the Humboldt Sink and WMA could have been at high enough concentrations in certain food items to pose some risk of adverse efforts to wildlife that occupy this area on a permanent or temporary basis. Indications of risk are apparent only when comparing measured tissue concentrations to literature-derived threshold values (see Table 3.4-4). Tissue concentrations of boron, mercury, and selenium exceeded one or more of the threshold values. However, no risk was indicated when considering the total dose that a receptor organism might receive. In addition, this evaluation is a simplistic and conservative one, and incorporates many factors that may overestimate the potential for adverse effects. First, the concentration data from Seiler et al. (1993) is limited; only a few samples were collected from the Humboldt Lake area, and those samples were not collected over a wide sample area. Had additional samples been collected over a longer period of time and over a wider area, different trends may have been observed and concentrations might have been higher or lower. It was assumed that 100 percent of water or diet came from the WMA. Because the area is very large, this assumption is likely to be true for the great blue heron and the mallard. However, the mule deer and bald eagle probably obtain food and water from areas outside of the WMA.

In summary, based on the study assumptions, available data from the literature, and likelihood of exposure, risks to avian and mammalian wildlife from metals and other constituents associated with premining conditions could occur, but these risks would be minimal. Because of the dynamic nature of the sink, the substantial influence of upstream water demand, potential naturally and artificially induced fluctuations in water level, and bioaccumulative nature of some metals (such as selenium and mercury), conditions in the sink should not be considered static, in terms of water quality or potential impacts to wildlife receptors.

### Potential Risk from Mine Discharge to the Sink

As discussed above, conditions in the Humboldt Sink are such that some risks to wildlife species using the sink could occur, although concentrations measured in water, sediment, and plant and animal tissues indicate the likelihood of impacts is low. Because, under normal conditions, there is no outflow from the sink, the total load of chemicals contained in the sink will increase with time. Unless these chemicals are removed from the sink by events such as flushing (e.g., to the Carson Sink) or wind (during dry periods), they will remain, primarily in the sediments. During mine discharges, additional quantities of some materials would be discharged into the Humboldt River, thus increasing the loads of these materials into the downstream sections of the Humboldt River system, as described in Section 3.2.2.2. An increase in the loading (measured in total quantity, such as tons) of materials would not necessarily result in an increase in risk to organisms using the sink, since it is the concentration (quantity of a material per unit volume or weight, such as milligrams/liter [mg/L] in water, or milligrams/kilogram [mg/kg] in sediments or tissue) of a chemical, and not its load, that controls risk to receptor organisms.

The anticipated increase in the load of selected constituents of concern as a result of mining activities is described in Section 3.2.2.2. Estimated loads to Rye Patch Reservoir and the Humboldt Sink were calculated based on

## Table 3.4-5
## NOAELS from Laboratory Studies Used to Estimate Risks to Wildlife

| Constituent | Test Organism | Dose (mg/kg bw/day)[1] | Source |
|---|---|---|---|
| Arsenic | mouse | 0.126[2] | Schroeder and Mitchener 1971 |
| | mallard | 5.14 | USFWS 1964 |
| Boron | rat | 28 | Weir and Fisher 1972 |
| | mallard | 28.8 | Smith and Anders 1989 |
| Chromium | rat | 17.61 | Steven et al. 1976 |
| | black duck | 1 | Haseltine et al. 1985 |
| Copper | sheep | 0.13[2] | Gopinath et al. 1974 |
| | chicken | 27.5 | Jackson and Stevenson 1981 |
| Lithium | rat | 9.4 | Marathe and Thomas 1986 |
| Mercury | mouse | 1.25 | Schroeder and Mitchener 1975 |
| | Japanese quail | 0.45 | Hill and Schaffner 1976 |
| Molybdenum | mouse | 0.26[2] | Schroeder and Mitchener 1971 |
| | chicken | 3.53[2] | Lepore and Miller 1965 |
| Selenium | rat | 0.2 | Rosenfeld and Beath 1954 |
| | mallard | 0.5 | Heinz et al. 1987 |
| Zinc | mouse | 125 | Aughey et al. 1977 |
| | chicken | 14.49 | Stahl et al. 1990 |

[1] Dose is based on the body weight (bw) of the test organism.
[2] These NOAELs were calculated by multiplying the LOAELs by an uncertainty factor of 0.1.

historical flows to these areas plus increased loading from the discharge. It is recognized that there are numerous factors that can influence the loading and, more importantly, the concentrations, of chemicals in the Humboldt River and associated lentic (lake) systems. This is especially true of the Humboldt River system downstream of Rye Patch Reservoir where water is diverted for agriculture. As water flows through this diversion system, chemicals in the water may be lost through deposition, and additional chemicals may be collected from the soil and any point and non-point discharges. There is also evaporative loss and consumptive use, which permanently removes water from the system. In addition, periods of high rainfall or drought conditions will affect the volume of materials that enter the Humboldt Sink, as well as their disposition once in the sink.

Estimates of future concentrations of selected constituents entering the Humboldt Sink were made with the understanding that these are general approximations and that certain factors could cause them to increase or decrease. Concentration estimates were calculated by dividing the estimated loads (converted to milligrams) by the total flow volume (in liters) discharged into the Humboldt Sink (Table 3.4-6). The predicted concentrations for arsenic, boron, copper, and zinc were compared to the mean, 1987-1990 surface water concentrations from Humboldt Lake, taken from Table 3.4-2. Except for zinc, the predicted concentrations are all less than the mean concentration used in the risk evaluation of the premining conditions. When the predicted zinc concentration (0.0114 mg/L) is used in the risk calculations, the hazard quotient for all receptor species would not change from premining conditions.

This evaluation of concentrations in the Humboldt Sink influent suggests that the additional loads to the Humboldt Sink associated with mining discharges would not pose additional risk to wildlife using the sink. As discussed under Premining Conditions, the concentrations of some constituents could be high enough to pose a chronic risk to organisms that use the Humboldt Sink; however, that risk would probably not be influenced by mine discharges into the Humboldt River. This conclusion is based on the best

### Table 3.4-6
### Estimated Concentrations of Select Constituents in Water Entering the Humboldt Sink (estimates combine the contribution from mines and baseflow)

| Source | TDS (mg/L) | As (mg/L) | B (mg/L) | Cu (mg/L) | F (mg/L) | Zn (mg/L) |
|---|---|---|---|---|---|---|
| Baseflow – No Mine Discharge | 2,936 | 0.0798 | 1.965 | 0.0023 | 1.887 | 0.0124 |
| Cumulative Mine Discharge | 388 | 0.0284 | 0.539 | 0.0034 | 1.891 | 0.0096 |
| Combined | 2,018 | 0.0613 | 1.452 | 0.0027 | 1.888 | 0.0114 |
| Mean pre-1996 Water Concentration In Humboldt Lake | Not Calculated | 0.095 | 4.014 | 0.0021 | Not Calculated | 0.009 |

information available to-date, including hydrogeological models and USGS/USFWS studies. However, the analyses supporting this conclusion have several uncertainties associated with them. For example, even though actual water, sediment, and tissue concentration data were available for the analysis, the samples reported by the USGS (Seiler et al. 1993; Seiler and Tuttle 1997) were collected infrequently and from only a few locations.

One of the most important unknown factors that could influence risks to wildlife in the sink is the effect of weather and associated precipitation. River flows and mine discharges could be affected by annual precipitation, which could increase or decrease water volumes as well as flush materials into the river from the watershed, thus causing significant alterations in chemical concentrations. Under dry, summer conditions, the total volume of the sink may be substantially reduced. As water evaporates, the concentration of solutes within the sink would increase. Although some materials would be lost to the sediments, the salinity (including trace metals) of the remaining water also would increase. At some point, concentrations of some constituents (including sodium, chloride, sulfate, and other common ions, as well as trace metals) may be high enough to be acutely or chronically toxic to wildlife consuming the water. There also may be a tendency for increased bioaccumulation of some ions, thus increasing risk through food ingestion. These events could occur, regardless of the presence of mine discharge. The presence of additional materials in the sink from mine discharges could result in higher concentrations in the event of dry-weather "lake shrinkage." However, there are currently no data available to evaluate this possibility. Lake size and weather conditions also could affect the type and number of receptor organisms in the sink. If conditions become too unfavorable, wildlife may leave the area, thus reducing risk through reduced exposure. Finally, conditions in the Humboldt Sink could affect risk to wildlife if the system were flushed with large volumes of water, or if drying and wind erosion removed sediment-bound materials. These physical changes to the environment also could affect the types and quantity of plants that grow in the sink, as well as the amount of time wildlife species spend in the area.

In summary, given the limited amount of information available, additional mine discharges to the Humboldt River would not likely cause an increase in risk to wildlife in the Humboldt Sink, beyond what exists under premining conditions. However, it is difficult to predict future conditions in the sink, and, therefore, the possibility exists that risks to wildlife could increase. Some unknown factors that could influence wildlife risks include:

- Precipitation – unusually high precipitation could increase water levels and dilute solutes, resulting in decreased concentrations of certain constituents. It also could encourage use of the area, possible increasing exposure for some species.

- Drought – unusually low precipitation could decrease water levels and concentrate solutes, resulting in increased concentrations and increased exposure. However, unusually low water levels could force some species to leave the area, thus reducing exposure.

- Effect of agricultural diversions upstream of the sink.
- Potential artificial or natural flushing of the area, which may remove materials.
- Loss of salts due to wind erosion.
- Water and sediment chemistry - ions could become trapped in sediments upstream of the sink or within the sink itself; they may or may not be remobilized if water chemistry changes.

### 3.4.3 Monitoring and Mitigation

If further reduction of surface waters were identified during the existing long-term surface water monitoring programs (see Section 3.2.3), Barrick would coordinate with the BLM to develop feasible water augmentation or improvement measures for affected springs or perennial stream reaches. This measure could include either on-site or off-site guzzler placements, small water pipelines, livestock fencing around existing surface water sources, etc. The feasibility of these options would be discussed relative to the habitat value and species affected in the long term.

To provide off-site habitat enhancement for terrestrial wildlife species, Barrick would coordinate with the BLM to implement specific changes in the land use of the Squaw Creek Allotment. The specific components of this measure would be discussed among the BLM, Barrick, and the lessee, and appropriate improvement measures would be implemented on Barrick's property.

### 3.4.4 Residual Effects

The primary residual effects to terrestrial wildlife would be the potential long-term loss or reduction of surface water availability and riparian, wetland, or mesic habitats for consumption, breeding sites, foraging activities, and cover from ground water drawdown. Other residual effects from impacts to the naturally occurring springs and perennial drainages from the water management operations would include animal displacement, a reduction in the relative carrying capacity of the plant community, and loss of overall habitat value for area species. Residual effects could result from the accumulation of metals in Humboldt WMA sediments and subsequent accumulation of materials in food items; however, flushing and wind erosion also could remove metals, thus keeping concentrations in sediment and biota at, or below, pre-mining concentrations.

### 3.4.5 Irreversible and Irretrievable Commitment of Resources

No irreversible commitment of resources would be anticipated for resident or migratory wildlife species associated with this project. However, the loss or long-term reduction in available water and riparian or wetland habitats would be considered an irretrievable commitment of resources for wildlife. The associated reduction in habitat carrying capacity; loss of cover, breeding sites, and foraging areas; animal displacement and potential loss from the population; and potential chronic effects from exposure to pit lake water quality would be considered irretrievable impacts that could occur in the long term.

# 3.5 Aquatic Resources

## 3.5.1 Affected Environment

The study area for aquatic resources encompasses four major drainages, which include the Boulder Creek subbasin, Maggie Creek subbasin, Rock Creek subbasin, and the Humboldt River. Of these four drainages, only the Boulder Creek subbasin was discussed in the original EIS for the Betze Project (BLM 1991a). The following information describes aquatic resources in each of the four drainages. The types of information used to characterize aquatic resources include habitat, fisheries, and macroinvertebrates. The discussion for the Boulder Creek subbasin focuses on new or updated information available since the Betze Project EIS was prepared.

### 3.5.1.1 Boulder Creek Subbasin

Habitat surveys were conducted in Rodeo, Brush, and Boulder Creeks in 1987 through 1993 (JBR 1994). Habitat quality was characterized as poor in the lower and middle portions of the streams, where relatively low flows, grazing, and erosion have affected the streams. Perennial sections of the streams such as the upper portion of Boulder Creek were characterized as moderate habitat quality. Qualitative sampling in 1988 and 1990 indicated that Lahontan speckled dace (*Rhinichthys osculus robustus*) was the only fish species present in Rodeo, Brush, and Boulder Creeks (JBR 1990b, 1988). This species is able to tolerate poor habitat conditions indicative of these streams.

Based on studies conducted in Rodeo, Brush, and the lower and middle portions of Boulder Creek from 1987 through 1993, macroinvertebrate communities were comprised of relatively few taxa that were highly tolerant of environmental stress (JBR 1994, 1992a). The number of taxa ranged from 3 to 16, while mean densities varied between approximately 200 and 3,500 individuals/m$^2$. Dominant taxa usually were chironomid midges, elmid beetles, and ostracods. The headwaters of Boulder Creek contained moderate numbers of macroinvertebrates and some pollution-sensitive taxa. In Brush and Rodeo Creeks, a shift towards pollution-tolerant taxa occurred beginning in 1990. Possible factors causing this shift included increased sediment loads and relatively low flows (JBR 1994). Brush Creek has been dry since 1994 as a result of mine dewatering (see Section 3.2.2.1) (Adrian Brown Consultants 1997).

### 3.5.1.2 Maggie Creek Subbasin

Diverse habitat conditions are present in the Maggie Creek subbasin. Maggie Creek and the lower reaches of most of the Maggie Creek tributaries were characterized as low-gradient streams with wide channels (BLM 1993b). Implementation of the Maggie Creek Watershed Restoration Program and controlled grazing on lower Susie Creek has stabilized banks and improved riparian vegetation. The lower reaches in Little Jack, Coyote, and Lynn creeks often dry up during the summer months due to low flows, which limits habitat conditions. In contrast, the headwaters of Little Jack, Coyote Creek, and Simon Creeks and the wet-meadow areas along lower Coyote and Little Jack Creeks contain stable, vegetated channels, with higher flows during the summer.

Beaver Creek originates on the east slope of the Tuscarora Mountains from small springs and seeps. The upper portion of the streamflows through deeply incised canyons, whereas the lower portion meanders through sagebrush-covered hills. In 1994, aquatic habitat was limited in the Beaver Creek drainage by channel size and streamflow (Valdez et al. 1994). Few large, quality pools with overhanging vegetation were present. Below approximately 6,500 feet in elevation, low flows reduced available aquatic habitat. A combination of riparian fencing and controlled grazing, initiated in 1993, has resulted in stable, well-vegetated streambanks and formation of quality pools since the 1994 survey was conducted (Evans 1999).

As part of mitigation for the South Operations Area Project, Newmont in conjunction with BLM and Elko Land and Livestock Company, implemented the Maggie Creek Watershed Restoration Project in 1993. The result of this mitigation plan is that aquatic habitat parameters such as riparian zone width, riparian condition class (percent optimum growth), stream width/depth ratio, bank overhang distance, woody vegetation overhang distance, and percent stream width with quality pools have improved significantly in the Maggie Creek subbasin since 1993 (BLM 1997a). Specific streams with improved conditions included mainstem Maggie, Coyote, Little Jack, and Simon creeks.

Electrofishing surveys were conducted in 10 streams within the Maggie Creek subbasin in 1992 (JBR 1992c). Eight of the streams contained fish populations, with speckled dace representing the most common and widespread species. Other species present included redside shiner (*Richardsonius balteatus*), mountain sucker (*Catostomus platyrhynchus*), brook trout (*Salvelinus fontinalis*), and Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) (LCT). Of these species, one is important as a recreational game fish species (brook trout) and one has Federally threatened status (LCT). Brook trout were present in Spring Creek, while Jack Creek, Little Jack Creek, and upper Maggie Creek contained LCT populations. See Appendix F for additional data on fisheries surveys. The upper 5.5 miles of Coyote Creek, which is located upstream of the 1992 study area, also supports a LCT population (BLM 1994b).

In 1997, fish sampling was conducted in seven streams (Lynn, Maggie, Beaver, Little Beaver, Spring, Little Jack, and Coyote Creeks) located within the Maggie Creek subbasin (AATA International 1997). Species collected in the streams included speckled dace, Lahontan redside (*Richardsonius egregius*), Tahoe sucker (*Catostomus tahoensis*), and LCT. Speckled dace was the most abundant species in the middle and lower portions of all streams. LCT were collected in the upper canyon portions of Beaver, Little Jack, and Coyote creeks, where they dominated the fish numbers. One LCT population also was found in a spring-fed reach in lower Jack (Indian) Creek. Additional information regarding the abundance, habitat preferences, and life history of LCT is provided in Section 3.6, Threatened, Endangered, Candidate, and Sensitive Species.

Fish communities in the Beaver Creek drainage, which flows into Maggie Creek, consist of four species: LCT, speckled dace, Lahontan redside, and Tahoe sucker (Valdez et al. 1994). Juvenile LCT were collected in seven of the nine streams; adults were captured in Beaver Creek, Little Beaver Creek, Toro Canyon, and three unnamed tributaries to Toro Canyon (see Appendix F). The lower segments of Beaver and Little Beaver Creeks also were surveyed in May 1997, with Lahontan redside shiner, speckled dace, and LCT collected in low numbers (AATA International 1998a). Two LCT were collected above the road culvert, these fish were assumed to have been washed downstream during high spring flows. Young-of-the-year were observed in Toro Canyon.

Based on studies conducted in November 1991 and April 1992, streams within the Maggie Creek subbasin exhibited differences in macroinvertebrate productivity and composition (BLM 1994b; JBR 1992c). Moderately diverse and productive communities were present in portions of Little Jack, Fish, Coyote, Maggie, James, Susie, West Cottonwood, Marys, Indian, and Mack Creek. In most instances, the productive and diverse communities were limited to the headwater portions of these streams. The macroinvertebrate assemblage in these streams consisted of a mixture of both pollution-tolerant and pollution-sensitive taxa. Mayflies (*Cinygmula, Drunella grandis*, and *Rhithrogena*), caddisflies (*Capnura, Isoperla*, and *Sweltsa*), and stoneflies (*Hydroptila, Lepidostoma,* and *Zapada*) represented the taxa that were considered sensitive to various types of environmental stress. The middle and lower portions of these streams usually were dominated by pollution-tolerant taxa such as chironomid midges, oligochaete worms, blackfly larvae, and mayflies (*Baetis*). Other streams, including Buck Rake Jack, Cherry Spring, Indian, Jack, Lynn, Simon, and Spring creeks, also contained communities dominated by pollution-tolerant taxa.

Macroinvertebrate sampling also was conducted in 1997 at sites within Little Jack, Spring, Coyote, Toro Canyon, and Beaver creeks (AATA International 1998a, 1997). Low to moderate densities were reported in the streams, with mayflies, caddisflies, Diptera, midges, and amphipods usually representing the most abundant taxa. The upper canyon portions of the streams contained taxa that indicated generally good water quality conditions, while the lower stream portions were dominated by pollution-tolerant taxa.

### 3.5.1.3 Rock Creek Subbasin

Aquatic habitat has been monitored in numerous streams within the Rock Creek subbasin with emphasis on those perennial segments that support LCT populations (AATA International 1998b; NDOW 1996b; BLM 1994b, 1998c). The following information summarizes habitat conditions in Rock Creek and its tributaries.

#### Upper Rock Creek

The upper 10 miles of Rock Creek exhibited fair to good habitat conditions in 1977 and 1997 (BLM 1998c). Although bank stability and pool width have declined since 1977, bank cover, stream width-to-depth ratio, and substrate composition have continued to be characterized as fair to good ratings (BLM 1998c). The upper reach contains stable banks and a well developed riparian zone.

#### Willow Creek

Habitat conditions in Willow Creek, both upstream and downstream of Willow Creek Reservoir, were rated as poor in 1977 (BLM 1994b). Lower Willow Creek below the reservoir was characterized by a complete absence of pools, unstable streambanks, high levels of sedimentation, and a lack of a well developed riparian zone. Limiting habitat parameters in the upper portion of Willow Creek included an absence of quality pools, unstable streambanks, and low to moderate sedimentation (NDOW 1996b). Cattle grazing has impacted the upper and lower portions of the stream. Surveys conducted in 1997 indicated improved habitat conditions (AATA International 1998b). Bank cover and width-to-depth ratio have improved since the earlier surveys (BLM 1998c).

#### Nelson Creek

Habitat conditions in this headwater tributary to Willow Creek were rated as fair in 1977 and poor in 1997. Limiting factors included sedimentation, few quality pools, unstable streambanks, lack of substrate diversity, and minimal bank cover (AATA International 1998b; NDOW 1996b; BLM 1994b). Cattle grazing and beaver activity have impacted the stream.

#### Lewis Creek

In general, this headwater tributary to Willow Creek exhibits higher quality habitat compared to most of the Rock Creek tributaries (BLM 1994b). Habitat conditions were rated as fair in 1977. In 1996, bank stability, bank cover, and substrate diversity were rated as fair (NDOW 1996b). A lack of quality pools and low pool/riffle ratio were considered major limiting factors. Habitat conditions were improved in 1997, as indicated by an excellent pool/riffle ratio, very good substrate material, low embeddedness, and bank overhang (AATA International 1998b).

#### Frazer Creek

Habitat conditions in the upper canyon portion of the stream were rated as poor in 1977, with limiting factors consisting of unstable banks, few quality pools, and lack of substrate diversity (BLM 1994b). In 1996 and 1997, the mid-canyon portion of the stream was rated as fair to excellent habitat quality (AATA International 1998b; BLM 1998c; NDOW 1996b). Stable banks, cover, diverse substrates, and a good mixture of pools and riffles contributed to the high quality habitat. The only limiting factor was a lack of quality pools. Habitat conditions were rated as fair in the lower reach, with a less developed riparian zone compared to the upper reach (BLM 1998c).

#### Toe Jam Creek

Of the 15-mile section with perennial flow, 13 miles were rated as poor habitat in 1977 (BLM 1994b). Factors limiting habitat quality consisted of unstable banks, lack of streamside vegetation, dominance of fine sediment substrates, and lack of pools with depth. The upper 2-mile section of Toe Jam Creek showed an improvement in bank stability, cover, and mixture of substrates. Habitat quality in 1997 indicated improved conditions, with an overall rating of fair to good aquatic habitat (AATA International 1998b; BLM 1998c). Limiting factors still exist, as indicated by substrate embeddedness and reduced bank cover and bank stability ratings (BLM 1998c).

Based on surveys conducted in the Rock Creek subbasin during June 1996 by NDOW, perennial streams contained LCT and native species such as Lahontan speckled dace, Tahoe sucker, mountain sucker, and redside shiner (NDOW 1996b). LCT were collected in Upper Rock Creek, Lewis Creek, Nelson Creek, Toe Jam Creek, and Frazer Creek. A more detailed discussion of LCT distribution in these streams is provided in Section 3.6, Threatened, Endangered, Candidate, and Sensitive Species. Lahontan speckled dace usually was the most abundant species in the streams. Electrofishing surveys also were conducted in three Rock Creek tributaries (Trout, Soldier, and Coyote creeks) during 1993 and 1996 (BLM 1997b, NDOW 1993b). Lahontan speckled dace was the only species present. Speckled dace, redside shiner, and Tahoe sucker were observed in Antelope Creek (McGuire 1995).

Based on surveys conducted in August 1997, macroinvertebrate communities in upper Rock, Toe Jam, Lewis, Nelson, and Frazer creeks exhibited relatively low densities and moderate taxa richness (AATA International 1998b). Total densities ranged from approximately 237 organisms/meter$^2$ (m$^2$) in Toe Jam Creek to 978 organisms/m$^2$ in upper Rock Creek. The total number of taxa ranged from 21 (Toe Jam Creek) to 33 (Frazer Creek). Mayflies and caddisflies were the most abundant groups in all streams. Other common taxa included dipterans (chironomid midges and blackfly larvae), stoneflies, and beetle larvae. The percent composition of mayflies, stoneflies, and caddisflies indicated generally good water conditions.

#### 3.5.1.4 Humboldt River Basin

Habitat conditions were characterized in 1997 (JBR 1997) at 13 locations extending from Carlin to approximately 2 miles downstream of the Rock Creek confluence (Appendix F, Table F-4). Habitat quality varied throughout the 55-mile section of the river, depending upon the extent of cattle grazing, abundance of pools, bank stability, and streamside cover. The upper four sampling locations (Barth to Dunphy) contained a fair to high abundance of pools; poor to excellent streamside cover; low to moderate grazing; and fair to good bank stability. From Dunphy downstream to the Rock Creek confluence, the river exhibited a fair to high abundance of pools; fair to good bank stability; and mostly low streamside cover.

Historical land use practices involving willow control, livestock grazing, and channelization along the Humboldt River have contributed to the generally less than optimal habitat conditions (Rawlings and Neel 1989). Other factors that have resulted in reduced habitat quality in the river include sediment loads, irrigation diversion, irrigation return flows, and relatively high water temperatures (BLM 1996b). Monitoring studies reported that irrigation return flows have contributed to elevated levels of arsenic in fish in Rye Patch Reservoir and downstream areas (Seiler et al. 1993).

The Humboldt River is considered a warm water fishery that consists of species that can tolerate relatively high sediment loads and warm temperatures. Twenty-three species were reported in previous surveys in the river, with sunfish, catfish, and minnow families containing the most species (see Appendix F, Table F-5). Game fish species occurring in the Humboldt River include channel catfish, white catfish, black bullhead, yellow perch, white bass, largemouth bass, smallmouth bass, sunfishes, and crappies. All of these game fish species were intentionally or accidentally introduced. The only native species in the river are suckers, Lahontan redside, redside shiner, Lahontan tui chub, and Lahontan speckled dace.

Electrofishing surveys were conducted in November and December 1995 at nine sampling locations in the Humboldt River that extended approximately 2 miles upstream of Dunphy downstream to the Rock Creek confluence (JBR 1997). Relative abundance information indicated that the minnow species and Lahontan mountain sucker were the most abundant species, while game fish numbers were relatively low. These results are similar to other surveys conducted in the Humboldt River (JBR 1992c).

Game fish inhabiting Rye Patch Reservoir include walleye, channel catfish, largemouth bass, smallmouth bass, spotted bass, white crappie, and yellow perch. In 1968, walleye (a cold water species) was stocked in Rye Patch Reservoir. Although the walleye population thrived during years with high streamflows, population declines occurred during dry years (BLM 1996b). The extended drought in the 1990s caused the walleye fishery to largely disappear. Presently, most of the remaining walleye spawn downstream of Mill City (French 1994, as cited in BLM 1996b). In the 1970s and early 1980s, walleye spawned between Rye Patch Reservoir and Winnemucca in late March and April at temperatures ranging from 50° to 53° F.

Game fish species comprise a minor portion of the overall fish numbers in the Humboldt Sink area (Sevon 1998). Recreational fishing in this area occurs relatively infrequently due to the low numbers of game fish and limited access. White bass and white crappie, which originate from Rye Patch Reservoir, are the most abundant game fish species in the Humboldt Sink. Other game fish species that are likely present include bullheads, channel catfish, white bass hybrids (wipers), walleye, largemouth bass, smallmouth bass, spotted bass, crappies, sunfishes, Sacramento perch, and yellow perch. Nongame species such as Tui chub, Sacramento blackfish, gambusia, and carp dominate the overall fish numbers. Aquatic habitat in the Humboldt Sink consists mainly of marshy areas with submersed and emergent vegetation.

Several monitoring programs are currently being conducted in the Humboldt River to provide information on community structure and environmental contaminants. Aquatic community structure and function are being assessed by the University of Nevada at 10 mainstem sampling sites. In addition, the USFWS and USGS are conducting a monitoring program to assess surface water quality and trace elements in aquatic vegetation, invertebrates, fish, and birds in the middle and lower portions of the Humboldt River (Wiemeyer and Tuttle 1997). Field data were collected in 1998 and 1999 for this program.

Thirteen locations, which extended from the Barth Mine near Carlin (upstream end) to approximately 2 miles downstream of the Rock Creek confluence (downstream end), were sampled for macroinvertebrates in the summer and fall of 1995 and 1996 (JBR 1997). Macroinvertebrate communities were low to moderately productive, with mean densities ranging from less than 100 to approximately 10,600 organisms/m$^2$. The highest densities occurred during the fall sampling period. The upper portion of the river from Barth to the Lander County levees contained a higher number of taxa (9 to 18), compared to 3 to 9 taxa in the lower section from Argenta Siding to below the Rock Creek confluence. In general, macroinvertebrate communities in the sampled portion of the Humboldt River were dominated by mostly tolerant taxa that have adapted to fluctuating flows and sedimentation. The most abundant taxa included chironomid midges, mayflies (*Tricorythodes minutus* and *Baetis*), and caddisflies (*Cheumatopysche* and *Hydropsyche*). The mayflies, *Cinygmula* and *Rhithrogena*, also were abundant during one or more sampling periods from Shoshone to the Lander County levees. These two taxa are sensitive to poor habitat conditions. Other sensitive taxa such as stoneflies (*Isoperla, Isogenoides*, and *Taenionema uinta*), caddisflies (*Culoptila* and *Glossosoma*), and dipterans (*Hexatoma, Erioptera*, and *Dicranota*) were present in relatively low numbers in the section between Carlin and the Lander County levees. These taxa were usually absent in the lower section of the river from Argenta Siding to below the Rock Creek confluence. Analyses of the Community Tolerance Quotient (CTQ), which rates the invertebrate's tolerance to environmental conditions, provided additional information regarding habitat conditions in the Humboldt River. The average CTQ values indicated fair habitat conditions in the section from between Carlin and the Lander County levees, and poor habitat conditions from Argenta Siding to below the Rock Creek confluence (JBR 1997).

Macroinvertebrate studies also were conducted between Battle Mountain and Winnemucca in 1995, 1996, and 1998 (Queen of the River Fish Company 1998). In 1998, the sampling stations ranged between Mote and the Eden Valley Bridge in Humboldt County. In general, taxonomic composition and densities were similar to upstream stations sampled by JBR (1997). In 1998, mean densities ranged from 886 organisms/m$^2$ near Mote to 10,488 organisms/m$^2$ near the Stonehouse Bridge. The most abundant taxa included chironomid midges, *Tricorythodes minutus* (mayflies), and *Hydropsyche* (caddisflies). The total number of taxa ranged from 9 to 15. Biotic indices, such as the Community Tolerance Quotient and Biotic Condition Index, indicated fair habitat conditions at Mote and the Stonehouse Bridge, and poor conditions at the Comus gage and Eden Valley Bridge. However, the 1998 data indicated improved conditions at the two downstream stations in comparison to 1995 and 1996 results.

## 3.5.2 Environmental Consequences

### 3.5.2.1 Impacts from Mine Dewatering and Localized Water Management Activities

Based on the results of the hydrologic modeling and geological characteristics of the various ground water and surface water resources, ground water drawdown from the Goldstrike Mine is not expected to affect springs and perennial waters on the eastern slope of the Tuscarora Mountains. Perennial streams in this area include Maggie, Beaver, Little Beaver, Coyote, Jack, Little Jack, Indian, Cottonwood, Lynn, and Simon creeks, which comprise the Maggie Creek subbasin. Springs and perennial reaches in the Rock Creek and Willow Creek area would not be affected. Since no substantial flow changes would occur in these streams, aquatic communities and their habitat would not be affected by Goldstrike Mine dewatering activities.

Both current and future drawdown would affect springs and some perennial reaches located within the Boulder Creek subbasin. Perennial streams in this subbasin include Rodeo, Brush, Bell, and Boulder creeks. Several springs and perennial and intermittent reaches in Brush and Rodeo creeks have been impacted by current dewatering activities. Brush Creek, a tributary to Rodeo Creek, has been dry since 1994. The effects of drawdown from current dewatering would be a loss of aquatic habitat, native fish (speckled dace), and macroinvertebrate communities. Future drawdown may affect additional springs and perennial reaches in this subbasin, particularly those water bodies located at lower elevations, which generally are not fed by perched springs. If springs and perennial reaches dried up, there would be a loss of aquatic habitat for dace and macroinvertebrates. Water-level reductions in springs and perennial reaches would decrease aquatic habitat and likely result in decreased numbers of dace and macroinvertebrates.

Dewatering activities also could reduce water levels in springs and perennial reaches within the upper Antelope Creek area. Native species such as speckled dace, redside shiner, and Tahoe sucker are present in this stream. Impacts on aquatic habitat and fish and macroinvertebrate communities would be similar to those discussed for the Boulder Creek subbasin.

Based on a review of water quality data, no major water quality trends have been observed to-date within the drawdown area in relation to flow reductions. Exceedences of NDEP water quality standards have been documented in the Boulder Creek subbasin, but it is not possible to determine if these changes resulted from flow reductions. Future exceedences of water quality standards likely would occur in the Boulder Creek subbasin. In general, speckled dace and macroinvertebrate taxa that inhabit these streams are tolerant to fluctuating temperatures, pH, flow, and other water quality parameters. It is anticipated these aquatic communities would not be affected by slight to moderate changes in water quality, regardless of whether they were caused by reduced flows or other factors.

To-date, no detectable changes in surface water quality have been identified in ground water mounding areas in the Boulder Creek subbasin; therefore, aquatic habitat and biota have not been affected by water management activities.

Future water management activities could cause increased sedimentation in the Boulder Creek subbasin streams. As previously mentioned, aquatic biota that inhabit those streams are generally tolerant to fluctuations in water quality conditions. However, if sediment loads covered substrate surfaces on a frequent basis, macroinvertebrate densities and taxa richness could be reduced.

### 3.5.2.2 Impacts to the Humboldt River

The effects of increased flows in the Humboldt River on aquatic communities and their habitat were analyzed in qualitative terms for both the present operating conditions and projected future conditions. The effects of these two operating scenarios on water quantity, water quality, and sedimentation are discussed in Section 3.2.2.2.

Barrick's maximum discharges to the Humboldt River occurred in 1997 and resulted in increased flows during all months at both the Battle Mountain and Comus gages. The highest relative change in flow occurred in August through November 1997. The effect of the increased flows on aquatic communities was an increase in the amount of available wetted habitat. This effect was most pronounced in the summer and fall months, when the river remained at relatively high levels. Pre-project conditions were characterized by relatively low flows in the summer, when portions of the channel dried up. Overall, an increased amount of habitat would be beneficial to aquatic communities by providing additional wetted area in the channel. The persistence of higher flows in the summer months should particularly benefit some of the introduced game fish species such as channel catfish, brown bullhead, black bullhead, largemouth bass, and smallmouth bass, which require higher river volumes. The native fish species inhabiting the Humboldt River have adapted to extreme fluctuations in flow. It is not known whether the removal of shallow pools that previously existed in the summer and fall months would affect the ecological requirements of some of the fish species. Most of the native fish species (particularly minnows) are able to spawn and develop in this type of habitat. The reduction of shallow, quiet water areas could affect the development of young fish for some of the fish species. After discharges cease, the amount of habitat available to fish would return to pre-discharge conditions.

Increased flows in the river are not expected to affect fish composition. Although depth increases of approximately 0.8 to 1.0 foot may allow wider dispersal in localized areas, these movements are not expected to affect competition between native and introduced species.

Overall, the effects of increased flows on macroinvertebrate communities would be beneficial, since additional wetted area would be available for development. Productivity would increase in the summer and fall months compared to pre-project conditions when portions of the river dried up. Community composition may change in the summer and fall months to reflect species that prefer relatively higher flows and depths. Taxa that inhabited shallow pools during the low flow period such as hemipterans (beetles), aquatic beetles, dragonfly, and damselfly larvae would likely exhibit reduced numbers, as a result of the increased flow depths. Insect orders that prevail in permanent flow conditions, such as mayflies, stoneflies, caddisflies, and chironomid midges, may exhibit increased densities and number of taxa (Williams 1996). After discharges cease, macroinvertebrate productivity and composition would return to pre-discharge conditions.

As discussed in the Section 3.2.2.2, Impacts to the Humboldt River, increased flows would not substantially increase channel erosion and sedimentation. One section of the river, particularly from Dunphy to Argenta, naturally exhibits large-scale erosion and sedimentation. Fish and macroinvertebrate have adapted to these conditions. It is anticipated that aquatic biota would be able to tolerate any additional sedimentation increase associated with Barrick's discharge.

Effluent discharges resulting from Barrick's present and future operations would not increase metal concentrations in the Humboldt River. Water quality monitoring of metal concentrations during the initial period of operation (October through December 1997) indicated that values did not exceed the NPDES limits, which are based on standards to protect warm water biota. Acute whole effluent toxicity testing for fathead minnow and *Daphnia* spp. (microcrustacean) provided additional evidence that the effluent was not acutely toxic to these organisms. Therefore, effluent discharges from Barrick's dewatering operation into the Humboldt River would not cause fish and macroinvertebrate mortalities as a result of elevated metal concentrations.

Effluent discharges resulting from present and future operations would cause a slight change in river temperatures (< 2°C) compared to pre-project conditions. This relatively small change would meet the State of Nevada standard for protecting warm water biota. Temperature monitoring of the effluent during the period October through December 1997 showed changes ranging from -1°C to +2°C. Temperature changes during future discharges would be expected to be within a similar range. Prior to Barrick's effluent discharge, the shallow braided channels usually existed in the river during the low-flow periods. Present and future discharges would increase water levels in the low-flow period, which may result in a slight increase in river temperatures. However, data are not available to quantify the magnitude of this potential temperature change during the low-flow period.

No flow changes in Humboldt River baseflows are predicted at the end of mining and 100 years postmining. Therefore, aquatic biota and habitat in the Humboldt River would not be impacted during these periods.

### 3.5.3 Monitoring and Mitigation

Native fish populations are known to occur in potentially impacted areas within the Boulder Creek and upper Antelope Creek drainages. Flows are being monitored in perennial reaches of the Boulder Creek drainage and upper Antelope Creek drainage, which contain habitat for native fish species. Representative reaches will be established in both of these drainages to monitor flows.

If existing surface water monitoring (see Section 3.2.3) indicates flow reductions in the Boulder Creek and upper Antelope Creek drainages BLM resource specialists would determine the need for mitigation. Two options would be used as mitigation: flow augmentation and off-site enhancement. If feasible, flow augmentation would be used for perennial reaches in the Boulder Creek and upper Antelope Creek drainages. Off-site enhancement would consist of improving land use practices in the Squaw Valley Allotment. Fencing would be used to limit grazing in areas near streams such as upper Rock, Toe Jam, and upper Willow creeks. Improvement in riparian vegetation and streambank stability in these streams would enhance habitat for native fish species.

### 3.5.4 Residual Impacts

There would be residual impacts to native fish species in study area streams. Although off-site enhancement would improve habitat for several streams in the upper Rock Creek drainage, these changes would not replace all affected perennial stream reaches in the Boulder Creek and upper Antelope Creek drainages.

### 3.5.5 Irreversible and Irretrievable Commitment of Resources

The loss of aquatic habitat (springs and perennial reaches) in the Boulder Creek subbasin and upper Antelope Creek, would be an irretrievable and potentially irreversible impact, if perennial stream reaches dry up. However, off-site enhancement (i.e., improved land use practices in the Squaw Valley Allotment) would mitigate for these irretrievable impacts.

# 3.6 Threatened, Endangered, Candidate, and Sensitive Species

## 3.6.1 Affected Environment

Table 3-6.1 summarizes the potential occurrence of special status species including threatened, endangered, candidate, and sensitive species of plants and animals on lands administered by the Elko BLM for this project (as of December 1999), including the area encompassing Barrick's water management operations. This list has been modified since the submittal of the Betze Project Draft EIS.

Nevada BLM policy is to provide Nevada BLM-sensitive and State of Nevada-listed species with the same level of protection as provided for candidate species (BLM Manual 6840.06C). Detailed discussions of sensitive wildlife species identified for Boulder Valley and surrounding areas can be reviewed in a number of sources including: BLM (1991c, 1993b, 1994b, and 1996a); Fox (1993); JBR (1989, 1990b, 1992a, b, d, and 1996a), NNHP (1997); Ports (1995, 1996), and Ports and Bradley (1996). The study area for both the direct and cumulative impact analyses for special status species is comprised of the cumulative assessment area as described in Section 3.2.1, Affected Environment, Water Resources, and Geochemistry.

### 3.6.1.1 Terrestrial Species

**Preble's Shrew**

Few site-specific data are available for the Preble's shrew, although it has been reported in the northern portion of the Great Basin. Suitable habitat ranges among sagebrush, grasslands, openings in subalpine forest, and alpine tundra (Fitzgerald et al. 1994; BLM 1993b). This small mammal also is believed to occupy wetland or marshy habitats containing adequate emergent and woody plant species (BLM 1993b, 1996c). The Preble's shrew has been documented in both Washoe County (Hoffmann and Fisher 1978) and in northern Elko County (Ports and George 1990). Currently, it is unknown whether this species occurs in the study area; however, suitable habitat occurs along perennial drainages in the Little Boulder Basin and east of the Tuscarora Mountains (BLM 1996a). The Preble's shrew also may occur along the Humboldt River drainage, since suitable habitat may be present along the river corridor and associated floodplains.

**Sensitive Bat Species**

Six special status bat species potentially occur within the project region. Of these, four have been positively documented in the study area, including the small-footed myotis, long-eared myotis, long-legged myotis, and Townsend's big-eared bat (see Table 3.6-1) (BLM 1996a, 1993b, 2000a; NNHP 1997; Ports 1995, 1996; JBR 1995b). The myotis species were primarily recorded foraging over riparian and open water habitats; a single Townsend's big-eared bat was observed roosting in an abandoned mine site in Boulder Valley (Ports 1995, 1996). Two male Townsend's big-eared bats were observed in the upper Lynn Creek drainage (BLM 1993b, 1996a, 2000a). Big-eared bats also have been recorded along the North Fork of the Humboldt River and in the northern Tuscarora Mountains (JBR 1995b). Although the current species' distribution of the Townsend's big-eared bat suggests that only the Pacific subspecies occurs in northeastern Nevada, the pale subspecies also has been documented (Bradley 2000). It is unknown which subspecies has been reported for the study area. The remaining two bat species identified as sensitive by the BLM (i.e., spotted bat and fringed myotis) could occur within the study area, based on habitat associations and previous field studies (Ports 1995; Ports and Bradley 1996). Habitat associations for all six of these species range among the upland shrub communities, woodland habitats (e.g., piñon-juniper), riparian areas, rock outcrops, cliff sites, and higher elevational woodland and wetland areas. Detailed information on habitat associations, breeding habits, foraging activities, and roost preferences are available in a number of publications, including: BLM (1996b, 2000a), Ports and Bradley (1996), JBR (1995b), Kunz (1990), Kunz and Martin (1982), Warner and Czaplewski (1984), Manning and Jones (1989), Colorado Division of Wildlife (1984), Arizona Game and Fish Department (1993), Zeveloff (1988), Bats of Nevada (no date), and General History of Nevada Bats (no date).

## Table 3.6-1
## Special Status Species Identified for the Betze Project Supplemental EIS

| Common Name | Scientific Name | Status[1] | Potential to Occur Within Water Management Operations[2] | Potential to Occur Within Proposed Action Area |
|---|---|---|---|---|
| **MAMMALS** | | | | |
| Preble's shrew | *Sorex preblei* | S | U[3] | U |
| Long-eared myotis | *Myotis evotis* | S | R | N/A |
| Small-footed myotis | *M. ciliolabrum* | S | R | N/A |
| Long-legged myotis | *M. volans* | S | R | U |
| Fringed myotis | *M. thysanodes* | S | U | U |
| Pale Townsend's big-eared bat | *Corynorhinus townsendii pallescens* | S | R | U |
| Pacific Townsend's big-eared bat | *C. t. townsendii* | S | R | U |
| Spotted bat | *Euderma maculatum* | N[4] | U | N/A |
| **BIRDS** | | | | |
| Bald eagle | *Haliaeetus leucocephalus* | T[5] | W, M | W, M |
| Golden eagle | *Aquila chrysaetos* | N | R | R |
| Northern goshawk | *Accipiter gentilis* | N | R | N/A |
| Swainson's hawk | *Buteo swainsoni* | N | R, M | R, M |
| Ferruginous hawk | *B. regalis* | N | R, M | R, M |
| Osprey | *Pandion haliaetus* | N | M | N/A |
| Burrowing owl | *Athene cunicularia* | N | R | R |
| Sage grouse | *Centrocercus urophasianus* | S | R | R |
| American white pelican | *Pelecanus erythrorhynchos* | N | M | N/A |
| White-faced ibis | *Plegadis chihi* | N | R, M | N/A |
| Black tern | *Chlidonias niger* | S | R, M | N/A |
| **PLANTS** | | | | |
| Lewis buckwheat | *Eriogonum lewisii* | S | P | N/A |
| **FISH** | | | | |
| Lahontan cutthroat trout | *Oncorhynchus clarki henshawi* | T | R | N/A |
| **AMPHIBIANS** | | | | |
| Columbia spotted frog | *Rana luteiventris* | C | R | N/A |
| **INVERTEBRATES** | | | | |
| Nevada viceroy | *Limenitus archippus lahontani* | S | R | N/A |
| California floater | *Anodonta californiensis* | S | R | N/A |
| Springsnails | *Pyrgulopsis* spp. | None[6] | R | N/A |

Sources: BLM 1996a; NNHP 1997; Ports 1995, 1996; Ports and Bradley 1996.

[1] Status:

E: Endangered: Federally listed species in danger of extinction throughout all or a significant portion of its range.

T: Threatened: Federally listed species likely to become endangered within the foreseeable future through all or a significant portion of its range.

C: Candidate: Species identified as warranted for Federal listing, but precluded by other actions to revise the lists.

S: BLM-sensitive species.

N: Nevada-listed species.

[2] Including the Humboldt River corridor.

## Table 3.6-1 (Continued)
## Special Status Species Identified for the Betze Project Supplemental EIS

[3]Potential Presence:
R = Resident yearlong.
P = Plant populations present.
W = Wintering.
M = Migratory.
U = Unknown whether this species occurs in the vicinity of the project; however, suitable habitat is present.
N/A = Potentially suitable habitat for this species in or near the proposed water pipeline right-of-way is not present or is not considered optimal.

[4]Per wording for Table IIa, in BLM Instruction Memorandum No. NV-98-013 for Nevada State protected animals that meet BLM's 6840 Policy Definition: Species of animals occurring on BLM-managed lands in Nevada that are: (1) protected under authority of Nevada Administrative Codes 501.100 – 503.104; (2) also have been determined to meet BLM's policy definition of "listing by a State in a category implying potential endangerment or extinction;" and (3) are not already included as BLM Special Status Species under federally listed, proposed, or candidate species. Nevada BLM policy is to provide these species with the same level of protection as is provided for candidate species in BLM Manual 6840.06C.

[5]Proposed to be delisted by the USFWS; final decision is pending.

[6]No designation but they are a concern due to their limited distribution.

Hibernacula, nursery colonies, and individual roost sites likely occur within the general region. However, little site-specific information on bat occurrences exists for the study area. Within eastern and northeastern Nevada, the small-footed myotis, long-eared myotis, and long-legged myotis have been reported as being the most common and widespread of resident bat species (Ports and Bradley 1996).

### Bald Eagle

The Federally listed bald eagle winters and migrates throughout north-central Nevada (BLM 1994b). Individuals often concentrate in proximity to open water areas during the winter season, where prey species (e.g., fish, waterfowl) may be more abundant, although eagles also utilize carrion and upland birds and mammals. Since 1989, NDOW has conducted winter surveys for birds of prey within the subbasins of Rock Creek, Boulder Creek, and Maggie Creek. Wintering bald eagles have been recorded during one or more of these surveys in all of these subbasins, with two to six eagles using each area (Bradley 1999). Limited open water areas are present during the winter period along Hot Creek and portions of Willow Creek Reservoir (Bradley 1999). No communal roost sites or nests have been reported in the project region (i.e., the Little Boulder Basin, Tuscarora Mountains, Independence Mountains, Sheep Creek Range, Adobe Range, or Humboldt River drainage) (BLM 1993b, 1994b, 1996a; JBR 1995b; Bradley 1999).

Wintering eagle use along the Humboldt River would be considered incidental (Neel 1999). Use would be associated with forage and roost site availability. The bald eagle also has been documented in the vicinity of the Humboldt Sink (Seiler et al. 1993; Seiler and Tuttle 1997; Neel 1999), which provides some foraging opportunities for wintering birds. However, the majority of the Humboldt Sink is frozen during the winter season (Neel 1999), which limits the number of eagles and extent of their use.

### Golden Eagle

The golden eagle occurs in nearly all habitat types of the western states, from desert grasslands to above timberline (Johnsgard 1990). In Nevada, the majority of eagles nest on suitable cliffs that overlook sagebrush flats, piñon-juniper forests, salt desert shrub or other habitats that support a suitable prey base (Herron et al. 1985). The golden eagle is a year-round resident within the study area. An active golden eagle nest site was documented along Boulder Creek in 1990 (JBR 1992a). A large number of roosting and foraging eagles also have been reported throughout the region, including along the mountains and drainages associated with the Tuscarora Range (JBR 1992a, f; EIP Associates 1994; Fox 1993). Consequently, it is assumed that golden eagles could nest or forage within the study area (including along the Humboldt River), based on potentially suitable habitat, regional historical records, and these recent sightings.

### Northern Goshawk

The northern goshawk is an uncommon forest species that is a year-round resident in northern Nevada, breeding in the higher elevations and wintering in the lower foothills and valleys (Herron et al. 1985). The northern goshawk primarily nests in the higher elevational woodland areas, particularly in aspen and conifer stands (Herron et al. 1985). Potential goshawk habitat within the study area is limited to forest and mountain shrub communities (BLM 1993b), which would be found predominantly in the Tuscarora Mountains, Independence Mountains, Sheep Creek Range, and Adobe Range. Breeding goshawks have been documented in the Independence Mountains (BLM 1993b), and historic NDOW data show the northern goshawk nesting in the northern Tuscarora Range.

### Swainson's Hawk

The Swainson's hawk is a summer resident of Nevada. Historically, this species was a common breeder in northern Nevada; however, current records indicate that this neotropical migrant is one of the least abundant raptors in the region. In Nevada, the majority of documented nesting territories occurred in agricultural valleys at elevations ranging from 4,000 to 6,500 feet. Nests have been found in buffaloberry, serviceberry, sagebrush, willow trees, and aspen; however, most of the documented nest sites occur in cottonwood or elm trees in agricultural valleys (Herron et al. 1985). In the study area, one pair of breeding Swainson's hawks was recorded on the Humboldt River floodplain in Lander County in 1987 (Bradley 1992), two Swainson's breeding territories were reported along the river southeast of Boulder Valley in 1992 (JBR 1992b), and territorial behavior was reported along the Humboldt River in the vicinity of Lone Tree Mine's discharge point in 1994 (BLM 1995b). Consequently, additional Swainson's hawk nests could potentially occur within the valleys and riparian zones associated with the study area.

### Ferruginous Hawk

This buteo often nests on trees, promontory points, rocky outcrops, cut banks, and infrequently on the ground (Terres 1991; Herron et al. 1985). In Nevada, its preferred breeding habitat is scattered piñon-juniper trees along the interface between the conifer woodland community and the lower desert shrub communities that generally overlook broad valleys used for foraging (Herron et al. 1985). One record of a nesting ferruginous hawk has been documented by the NDOW on the Carlin Trend, and individuals have been recorded in Boulder Valley during spring migration (JBR 1992a). Ferruginous hawks nest in the Tuscarora Mountains (JBR 1996a) and reportedly concentrate in late summer and early fall near the wet meadows associated with the upper reaches of Maggie Creek. This area appears to be a staging area used by the hawks prior to migrating (BLM 1993b). Suitable nesting habitat is limited in the Little Boulder Basin, but individual hawks likely forage within the basin and surrounding areas (JBR 1996a, 1995b). This raptor species also occurs along the Humboldt River drainage. Active nesting along the river would depend on suitable nest substrates, adequate prey base, and minimal human activities in proximity to the nest. In 1994, an active ferruginous hawk nest was recorded in a buffaloberry shrub in the vicinity of a water discharge ditch for the Lone Tree Mine (BLM 1995b), upstream of the Comus Gage.

### Osprey

The osprey is primarily a spring and fall migrant in Nevada. Ospreys typically nest in dead snags or in trees within a mile or more from water, but have been known to nest on cliffs, on the ground, and on man-made structures (i.e., power poles, chimneys, windmills, channel buoys, and duck blinds) (Herron et al. 1985). In Nevada, only one nesting pair of osprey was recorded at Lake Tahoe in the 1970s. Since then, failed attempts have been made to attract breeding pairs to Marlette Lake, located 2 miles east of Lake Tahoe, by constructing nesting platforms (Reyser

1985). The diet of this raptor species consists primarily of fish that is usually captured near the water surface, but other sources of food include small mammals, birds, reptiles, and amphibians. Although breeding would be considered unlikely within the study area, migrating osprey may occasionally roost and forage within the region. One osprey was recorded along the Humboldt River in 1988 near the Herrin Slough in Humboldt County. This bird was thought to be a migrant nonbreeder (Neel 1994).

### Burrowing Owl

The burrowing owl is a confirmed nesting species in lower Boulder Valley (JBR 1996a) within the study area. In Nevada, burrowing owls have been observed primarily in disturbed sites such as recently burned areas or new troughs, corrals, or mineral licks where livestock concentrates. Nesting habitat for this owl species consists of abandoned mammal burrows on flat, dry, and relatively open terrain. This small owl typically forages in open grassland and sagebrush communities and feeds on insects, small rodents, small birds, reptiles, and amphibians (Terres 1991). Since the burrowing owl generally depends on mammal burrows for nesting, along the Humboldt River it would be restricted to more upland communities.

### Sage Grouse

The sage grouse is becoming a focus of western United States land managers and regulatory agencies. A widespread reduction in available sagebrush habitat from wildfire events, livestock management, increased residential and urban development, and resource development activities has resulted in an incremental loss of breeding, nesting, and wintering areas for this species. In addition, the ongoing reduction in riparian and associated mesic communities in the arid portions of the West continues to reduce optimal brooding habitat for this grouse species. The western sage grouse may be petitioned for Federal listing in 2000; however, it is currently unknown when and if this will occur. In the interim, the sage grouse is classified as a BLM-sensitive species and is afforded the same level of protection on BLM lands as Federal candidate species.

Within the study area, sage grouse use the upland sagebrush habitat in rolling hills and benches along drainages for breeding, nesting, and wintering. Mesic and riparian habitats are especially important during brooding and molting periods. Active sage grouse breeding sites, called leks, historically occurred throughout the study area. Since the quality of suitable breeding habitat typically improves with higher elevations, a greater number of grouse leks occur along the foothill regions and in the higher meadows (e.g., upper Rock Creek, northern Tuscaroras, Squaw Valley Ranch) (Lamp 1999). However, previous range fires and subsequent seeding of perennial grasses have reduced the overall habitat value for sage grouse in the Little Boulder Basin west of the Tuscarora Range (JBR 1989). In addition to their wildlife value, sage grouse also are important to the Western Shoshone Culture (see Section 10.2.2).

Available data on historical sage grouse leks within the study area are patchy and scattered. The most comprehensive record of historic lek sites recorded for the study area was obtained from the NDOW's state-wide database (NDOW 1998c) and supplemented with active leks recorded by JBR (1992g) for the study area. An additional sage grouse survey was conducted in April 1995 to determine if historic lek sites located north of the Meikle Mine were active (ENSR 1995). Overall surveys conducted within the Little Boulder Basin infer a general population decline, based on lek counts and reduced use of satellite leks by males in 1989 and 1990 (JBR 1992a). Several of the historic leks were recorded in the 1980s and early 1990s. Because of the recent wildfire events and ongoing mining operations along the Carlin Trend, it is unknown whether the majority of these sites are currently active.

Although a review of the available data indicated a few concentration areas in and near the study area, it is assumed that sage grouse could occur within potentially suitable habitats (i.e., upland, mesic, and riparian) within the entire region, including along the Humboldt River corridor. Exact lek locations are not shown, due to the sensitivity of these breeding sites; however, a summary of the historic lek locations is presented in an effort to characterize past and present use of the entire study area by breeding, nesting, and brooding sage grouse.

A large lek and several small satellite leks have been documented in Little Boulder Basin on the terrace south of Bell Creek (BLM 1994a). Based on historic mapping, approximately 10 to 15 leks have been documented on benches north of the Willow Creek drainage, and 3 historic leks were located north of Antelope Creek (NDOW 1998c). Ten to 15 leks have been recorded in the upper Maggie Creek drainage, in the northern Independence Range, and 5 leks were associated with the southern Independence Range (NDOW 1998c; JBR 1992g). Three leks were documented along the eastern flanks of the Tuscarora Range, 4 leks in the Adobe Range, and up to 7 leks were associated with drainages located west of the Adobe Range, including along Susie Creek and Sixteenmile Creek (NDOW 1998c; JBR 1992g). Few breeding or nesting grouse were recorded along the Humboldt River during the 1988 surveys (Nell 1994); however, it is assumed that they occur in suitable areas.

As stated above, a number of these leks may not be currently active. The lek summary provided for the study area was developed as a basic reference for the impact analysis presented in Section 3.6.2 and the cumulative impact analysis in Section 5.6.

### American White Pelican

The American white pelican breeds only at a few locations in the western and north-central United States. In Nevada, white pelicans breed at Pyramid Lake in Washoe County. Nesting habitat consists of inaccessible islands that provide protection from coyotes and other marauding predators, and productive, shallow-water fishing grounds. This species feeds primarily on fish species including the tui chub that occurs in Pyramid Lake and surrounding water bodies. Foraging by the Pyramid Lake colony has been documented 100 miles south of the breeding grounds to Washoe Lake, and as far as 60 miles south and east to Lahontan Reservoir, Humboldt Sink, and the Stillwater marshes (Ryser 1985). During spring migration, white pelicans begin to arrive on their breeding grounds from mid to late March. Post-breeding and migratory movement studies indicate that while adult pelicans generally move northeast and northwest from Pyramid Lake into Utah, Idaho, and Oregon, most of the young pelicans move westward into central California (Ryser 1985). Consequently, based on this species' current distribution and common habitat associations, presence within the study area would be limited to potential migrating and foraging pelicans.

### White-Faced Ibis and Black Tern

Wet meadows and both perennial and intermittent wetlands provide habitat for resident and migratory shorebirds, including the white-faced ibis and black tern (Terres 1991). Within the arid habitats of northern Nevada, potential nesting or foraging habitat for these bird species typically fluctuates with available water.

The white-faced ibis has been documented using the Boulder Valley springs, TS Ranch Reservoir, and associated diversion canals within the Little Boulder Basin (ENSR 1995; JBR 1996a). Additional habitats located in the study area for these two water bird species include the wet meadows located along the perennial portions of the drainages occurring in Boulder Valley; along Maggie, Coyote, and Little Jack creeks; and in the Tuscarora Mountains, Independence Mountains, Sheep Creek Range, and Adobe Range (BLM 1993b, 2000a). These species also may use irrigated agricultural lands.

As discussed for general shorebird species in Section 3.4.1.3, shorebird occurrences in the Little Boulder Basin have been closely associated with surface water availability. Shorebird numbers were high during the early 1990s because of the high water levels in the TS Ranch Reservoir, at the associated springs (i.e., Knob, Green, and Sand Dune), and along the irrigation ditch located south of these springs. As the area of surface water diminished during periods when no water was discharged to the reservoir, the amount of suitable habitat within the basin also declined. Therefore, shorebird numbers have fluctuated according to these changing water levels.

Both the ibis and tern have been observed along the Humboldt River (Alcorn 1988; Neel 1994, 1998; Bradley 1992; Bradley and Neel 1990), and terns are occasionally reported in northeastern Nevada, particularly the Ruby Marshes (Alcorn 1988). Historically, white-faced ibis foraged in the sloughs and flooded meadows along the Humboldt River and nested in the emergent vegetation. Currently, the majority of the habitat types that supported nesting ibis have been removed from the Humboldt system (Neel 1994), and ibis populations are declining in the western United States. The majority of white-faced ibis breed within the Great Basin area (Neel 1994). Therefore, the ibis is considered a BLM-sensitive species because of the declining population trends and the reduction in wetland habitats currently occurring within the Great Basin, and specifically Nevada.

In 1986, a nesting colony of 10 white-faced ibis pairs was recorded downstream of Battle Mountain (Bradley and Neel 1990). In 1987, white-faced ibis were documented by the NDOW during the breeding season upstream of Battle Mountain (Bradley 1992), and ibis were reported along the river in 1992 upstream of the mines' discharge points (JBR 1992b). In 1999, a very large nesting colony of white-faced ibis was recorded at the Humboldt Sink. Prominent ibis nesting areas occur at the Herrin Slough (Neel 1994), along the northern portion of Rye Patch Reservoir, at the Humboldt Sink (Humboldt Wildlife Management Area), and south at Carson Lake (Stillwater Wildlife Management Area) (Saake 1998; Neel 1998; Seiler et al. 1993). Typically, white-faced ibis range along the Humboldt River, following the patterns of flood irrigation (Neel 1994).

The black tern is an uncommon nesting species in the Great Basin. Black terns have been recorded along the Humboldt River near Golconda (Neel 1994), downstream of the Comus Gage. This species also could occur in other locations that provide potentially suitable habitat for breeding or foraging.

#### Nevada Viceroy

This butterfly species is typically associated with willow (*Salix exigua*) habitat, which is used by the larval stage as a host plant (Herlan 1971). Its known distribution is limited to riparian habitat in valley floors below approximately 6,000 feet in elevation. The Nevada viceroy is not abundant in its present distributional range. The use of herbicides and burning of willow species along canals and streambanks have affected the species' distribution (Herlan 1971).

The Nevada viceroy occurs in riparian areas along the Humboldt River and its tributaries (Austin 1998). This butterfly has been reported from Dunphy, Beowawe, and Elko (JBR 1992e) and was observed along the Humboldt River and Maggie Creek in 1990 (BLM 1996a). Approximately 446 acres of potential habitat for the Nevada viceroy was identified and mapped along Little Jack, lower Susie, and Maggie creeks (BLM 1993b). Potentially suitable habitat also occurs along Coyote, Boulder, and Bell creeks; however, no Nevada viceroys have been documented (BLM 1993b, 1996a).

#### Lewis Buckwheat

Lewis buckwheat is a mounded or matted perennial forb that is restricted to dry, open, relatively barren and undisturbed convex ridge-line knolls and crests underlain by siliceous carbonate and limestone rock types on all aspects (Morefield 1996). Known habitat is characterized by sparse to moderately dense vegetation, typically including low sagebrush (*Artemisia arbuscula*), green rabbitbrush (*Chrysothamnus viscidiflorus*), Indian ricegrass (*Oryzopsis hymenoides*), and squirreltail (*Elymus elymoides*). Lewis buckwheat is endemic to north-central Elko County and northern Eureka County, Nevada; in the Bull Run, Independence, and Tuscarora Mountains; and in the Jarbidge Mountains complex (Morefield 1996). A total of 33 populations, including approximately 665,000 plants, are known to occur in 10 general areas. These populations cover approximately 118 acres on National Forest, private, BLM, and Elko County lands between 6,470 and 9,720 feet in elevation. The majority of these populations have been affected by road-building activities, livestock trampling, fire suppression activities, and mineral exploration. Three of the 33 known populations occur in the central portion of the study area, more specifically, north of Emigrant Pass and adjacent to Marys Mountain at approximately 6,960 to 8,337 feet (Morefield 1996).

### 3.6.1.2 Aquatic Species

Three aquatic threatened, candidate, and BLM-sensitive species potentially occur within the study area. Of these species, Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*) (LCT) is the only Federally listed species (threatened). The

California floater (*Anodonta californiensis*) is a BLM-sensitive species. The Columbia spotted frog (*Rana luteiventris*) is a Federal candidate species. Springsnails currently have no BLM designation; however, they are important because of their limited occurrence and potential for future listing or identification as a candidate or sensitive species. The following discussion summarizes the distribution, abundance, and habitat used by these species or group of species (i.e., springsnails). Habitat characteristics of streams located within the Maggie and Rock Creek subbasins are described in Sections 3.5.1.2 and 3.5.1.3, respectively. Although the Lahontan speckled dace was discussed in the previous EIS, this species is no longer considered a listed or BLM-sensitive species.

## Lahontan Cutthroat Trout

The LCT was initially listed as Federally endangered in 1970, but its status was changed to threatened in 1975 to legalize angling and provide for improved management of the species. Historically, LCT occupied streams throughout the Humboldt River drainage. Presently, this species occurs in 83 to 93 streams in the Humboldt River basin, or approximately 318 stream miles (Coffin and Cowan 1995). This constitutes approximately 14 percent of their historic habitat range. Most existing populations are found in eight subbasins that include Marys River, Maggie Creek, Rock Creek, North Fork Humboldt River, East Fork Humboldt River, South Fork Humboldt River, Little Humboldt River, and Reese River.

**Maggie Creek Subbasin**. The present distribution of LCT within the Maggie Creek subbasin is limited to the following streams: Little Jack Creek, Jack Creek, Coyote Creek, Beaver Creek, Little Beaver Creek, Toro Canyon, Williams Canyon, and mainstem Maggie Creek (Figure 3.6-1). A new population also was documented in Lone Mountain Creek, a tributary to Maggie Creek located in the upper portion of the drainage (Elliott 2000). The estimated miles of occupied habitat in these subbasin streams is listed in Table 3.6-2. The length of occupied habitat may vary annually depending upon streamflows and water temperatures. Of these seven streams, Beaver, Coyote, and Little Jack creeks contain the highest quantity of presently occupied habitat. The present distribution of LCT in the mainstem portion of Maggie Creek is limited to a few scattered locations within an 8-mile segment (Figure 3.6-1). Presently, LCT numbers in Maggie Creek are reduced in comparison to historic numbers. The entire 8-mile

Table 3.6-2
Estimated Miles of Occupied LCT Habitat in the Maggie Creek and Rock Creek Subbasins

| Maggie Creek Subbasin | Occupied[1] |
|---|---|
| Maggie Creek Mainstem | 8.0 |
| Little Jack Creek | 4.6 |
| Coyote Creek | 5.2 |
| Beaver Creek | 7.1 |
| Little Beaver Creek | 1.1 |
| Toro Canyon Creek | 2.3 |
| Williams Canyon | 1.1 |
| Jack (Indian Creek) | Unknown |
| Lone Mountain Creek | Unknown |
| **Rock Creek Subbasin** | **Occupied[1]** |
| Frazer Creek | 2.6 |
| Toe Jam Creek | 4.5 |
| Lewis Creek | 3.1 |
| Nelson Creek | 4.1 |
| Rock Creek | 4.2 |
| Willow Creek Reservoir | 2.2 |

[1] Occupied habitat may vary annually based on streamflow, temperature, and habitat conditions.

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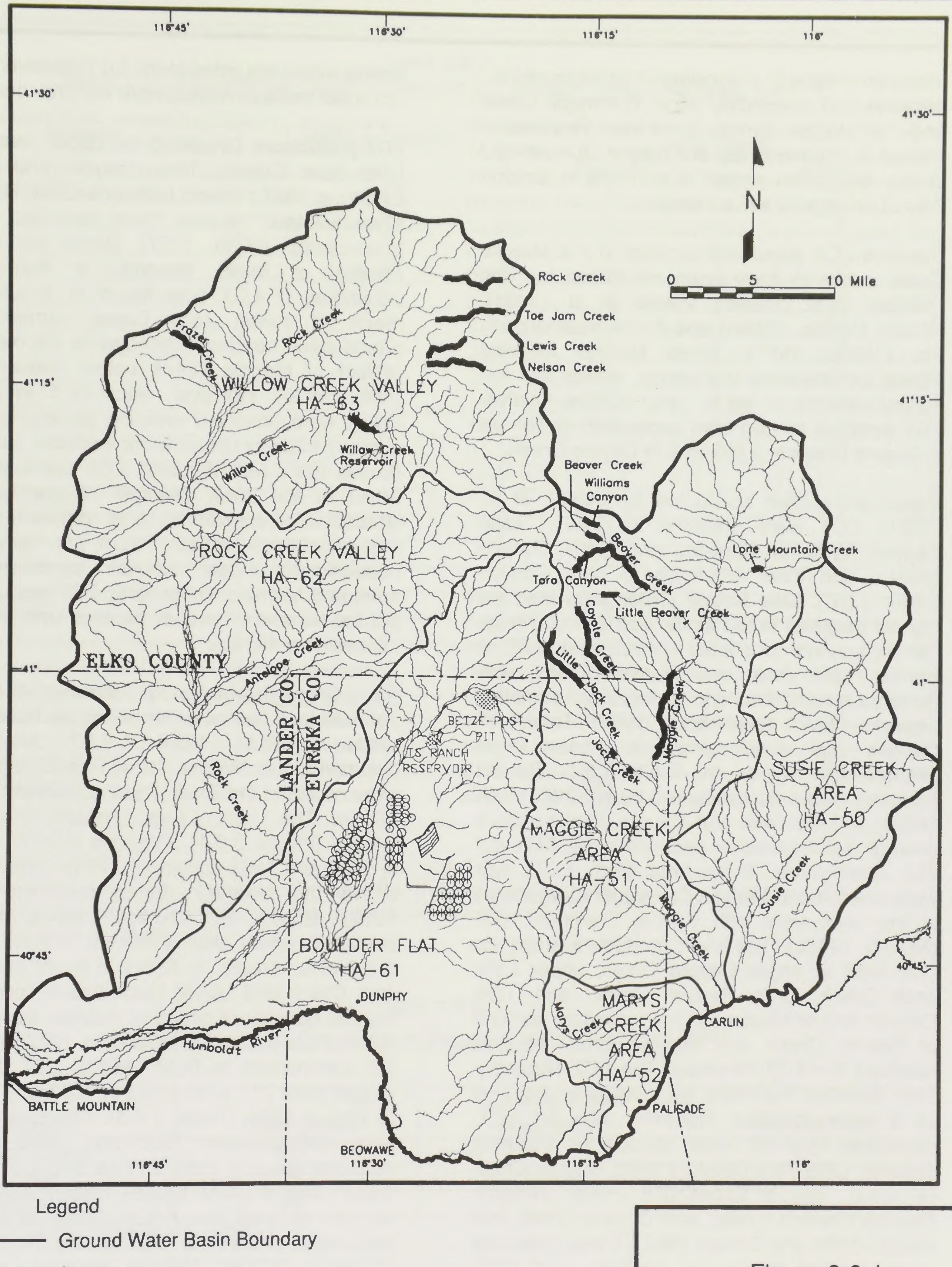

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Ground Water Basin Boundary

Stream

County

Current Distribution of Lahontan Cutthroat Trout

○ Center Pivot Irrigation

Figure 3.6-1

Current Distribution of Lahontan Cutthroat Trout mainstem segment is considered potential habitat because LCT historically occur in Maggie Creek and the Maggie Creek Watershed Restoration Project is improving aquatic habitat. A summary of this restoration project is provided in Section 3.5.1.2, Maggie Creek subbasin.

Previous LCT population surveys in the Maggie Creek subbasin have been conducted by JBR (1992a), BLM (1994b), Valdez et al. (1994), NDOW (1998b, 1996b) and AATA International, Inc. (1998a, 1997). These surveys followed similar electrofishing techniques, except that the survey distance varied in some studies. Overall, LCT densities ranged from approximately 15/mile in Beaver Creek to 2,592/mile in Coyote Creek.

Based on studies conducted by Valdez et al. (1994), LCT were collected in Beaver, Little Beaver, Williams Canyon, and Toro Canyon Creeks, and three tributaries to Toro Canyon (Table 3.6-3). Little Beaver Creek supported the highest densities in this study, with 704 LCT/mile. Recent surveys conducted in 1997 found LCT in Beaver, Little Jack, and Coyote Creeks, with densities ranging from 1 to 52 fish/328 ft sampling segment (AATA International 1997). Total LCT catches and densities/mile for these three streams are shown in Table 3.6-4. Recent sampling also was conducted by NDOW (1999, 1996b) in Little Jack and Coyote creeks, where average LCT densities per mile were 647 and 634, respectively. Three trout (likely LCT) also were observed in Maggie Creek just downstream of the confluence with Coyote Creek in 1997 (NDOW 1998b). The most productive areas for LCT exist in upper Coyote Creek, upper Little Jack Creek, Little Beaver Creek, and Toro Canyon and its tributaries. The mainstem portions of Beaver Creek and Maggie Creek support relatively low LCT densities. The LCT Recovery Plan identified the entire Maggie Creek drainage as a metapopulation. Recovery sites for LCT, expressed in linear miles, include the following streams: Little Jack Creek (1 mile), Maggie Creek (4 miles), Beaver Creek (2.8 miles), Williams Canyon Creek (1 mile) and Coyote Creek (4.8 miles) (Coffin and Cowan 1995). These distances were based on information available as of 1995, and were not intended to limit recovery activities to a specific stream length, or preclude inclusion of additional streams where LCT have been documented. Toro Canyon and Little Beaver creeks also were listed in the LCT Recovery Plan, but linear miles of habitat were not provided.

LCT populations inhabiting the upper canyons of Little Jack, Coyote, Toro Canyon, and Beaver Creeks in 1997 showed evidence of reproduction, since young-of-the-year were abundant (AATA International 1998a, 1997). Below the canyon mouths of these streams, a reproductive population of LCT was found in a spring-fed reach of lower Jack Creek. Limited LCT reproduction has been detected in the mainstem portion of Maggie Creek below beaver dams (JBR 1992e). However, adult LCT in Maggie Creek were observed entering (or attempting to access) tributary streams for possible spawning (Evans 1999; NDOW 1999). LCT that have been found in the lower reaches of the subbasin streams were considered to be "outwash victims" that have been removed from the reproducing populations. Winter habitat conditions are adequate to maintain existing LCT populations, but the number of deeper pools is limited (AATA International 1998c).

**Rock Creek Subbasin**. An estimated 25 miles of potential LCT habitat exists within the Rock Creek subbasin (BLM 1994b). LCT has been documented in Willow Creek Reservoir and six streams within the Rock Creek subbasin: Frazer, Willow, Toe Jam, Lewis, Nelson, and Rock Creeks (Figure 3.6-1). Previous NDOW surveys in 1959 and 1986 collected LCT in Willow Creek above the reservoir during spawning (Elliott 1999). Based on Aronson (1998), potential seasonal habitat also is present in Rock, Lewis, and Nelson creeks. In terms of linear miles, Toe Jam Creek and Upper Rock Creek contain the highest quantity of occupied habitat. Based on a surveys conducted by NDOW in 1977 and 1996 (as summarized in BLM 1998c), LCT densities ranged from 211 to 581/mile in 1977 and from 70 to 854 in 1996 (Table 3.6-5). Previous surveys conducted between 1955 and 1986 reported densities ranging from 211 to 616 LCT/mile in these streams (BLM 1994b). Recent and historic surveys showed that Frazer Creek is the most productive stream for LCT in the Rock Creek subbasin. NDOW (1996b) reported moderate LCT densities in 1996 (853/mile), while 2,600 LCT/mile were estimated in 1971 (BLM 1994b). Recovery habitat has been identified in

## Table 3.6-3
## Mean LCT Abundance[1] (number/mile) in the Beaver Creek Drainage, 1994

| Stream | Location Number | Life Stage | |
|---|---|---|---|
| | | Juvenile | Adult |
| Beaver Creek | 1 | 0 | 10 |
| | 2 | 0 | 0 |
| | 3 | 0 | 0 |
| | 4 | 44 | 0 |
| | 5 | 0 | 0 |
| | 6 | 28 | 28 |
| | 7 | 15 | 15 |
| | 8 | 43 | 43 |
| | 9 | 128 | 0 |
| | 10 | 15 | 0 |
| | 11 | 0 | 0 |
| | | | |
| Williams Canyon | 1 | 0 | 0 |
| | 2 | 81 | 0 |
| | 3 | 132 | 0 |
| | | | |
| Toro Canyon | 1 | 0 | 0 |
| | 2 | 170 | 34 |
| | 3 | 270 | 0 |
| | 4 | 114 | 0 |
| | 5 | 103 | 26 |
| | | | |
| Toro Tributary A | 1 | 128 | 64 |
| Toro Tributary B | 1 | 313 | 0 |
| Toro Tributary C | 1 | 328 | 0 |
| | | | |
| Little Beaver Creek | 1 | 0 | 0 |
| | 2 | 634 | 70 |

[1] Number of fish/sampling segment (in feet) was extrapolated to number/mile.

Source: Valdez et al. (1994).

## Table 3.6-4
## Summary of LCT Densities in Maggie Creek Tributaries, 1997

| Stream | Total Catch | No. of 328-foot Segments | Density/Mile |
|---|---|---|---|
| Little Jack Creek | 80 | 13 | 99 |
| Beaver Creek | 2 | 4 | 8 |
| Coyote Creek | 45 | 5 | 145 |

Source: AATA International, Inc. (1997).

### Table 3.6-5
### LCT Densities for Rock Creek Subbasin Tributaries

| Stream | 1977 | | | 1996 | | |
|---|---|---|---|---|---|---|
| | LCT/Mile | No. of Age Classes | Occupied Habitat (miles) | LCT/Mile | No. of Age Classes | Occupied Habitat (miles) |
| Toe Jam Creek | 581 | 3 | 4.7 | 106 | 2 | 4.5 |
| Upper Rock Creek | 282 | 4 | 5.0 | 70 | 2 | 5.0 |
| Upper Willow Creek[1] | 211 | 2 | 1.0 | 290[2] | 2 | 1.0 |
| Frazer Creek | 320 | 5 | 1.0 | 854 | 5 | 2.0 |

Source: BLM (1998c).

[1] Survey reach extended from above Willow Creek Reservoir to the confluence with Lewis Creek.

[2] The same area was surveyed in 1977 and 1996; however, this portion of Upper Willow Creek was reported by NDOW (1996c) as being part of Lewis Creek.

the following six streams: Frazer Creek (1.5 miles), Lewis Creek (3.8 miles), Nelson Creek (2.6 miles), Upper Rock Creek (10.0 miles), Toe Jam Creek (6.0 miles), and Upper Willow Creek (1.0 mile) (Coffin and Cowan 1995). As previously mentioned, these approximate distances were based on information available as of 1995.

The presence of YOY and yearling-sized LCT in Nelson, Toe Jam, Lewis, and Rock Creeks during 1997 indicated recent reproductive success (AATA International 1998d). Although overwintering habitat exists in the Rock Creek subbasin, it is suboptimal due to the general lack of deep pools typically provided by beaver ponds. Isolated ponds exist, which are often used by LCT.

**Ecology and Life History**. In general, riverine populations of LCT inhabit small streams with cool water; pools in proximity to cover and velocity breaks; well vegetated and stable stream banks; and relatively silt-free, rocky substrate in riffle-run areas (Coffin and Cowan 1995). Within the Humboldt River basin, LCT can tolerate temperatures exceeding 80°F for short periods of time and daily fluctuations of 25° to 35°F (Coffin 1983; French and Curran 1991). Habitat characteristics of collection sites in Little Jack Creek included pools with overhanging vegetation and gravel substrates (JBR 1992e). Ideal overwintering habitat consists of deep pools (depths ≥3 feet) with abundant cover such as large woody debris and undercut banks (AATA International 1998d). Beaver ponds, which provide this type of overwintering habitat, are increasing in Maggie, Beaver, Susie, and Rock creeks due to increased availability of willows.

LCT spawning typically occurs from April through July, depending on stream conditions such as flow, water temperature, and elevation. Spawning behavior is similar to other stream-spawning trout, which involves eggs being layed in redds dug in riffle areas over gravel substrates (Coffin and Cowan 1995). Adult maturity is 3 to 4 years for females and 2 to 3 years for males. Generally, spawning occurs every 1 to 2 years rather than consecutive-year spawning. LCT spawning migrations usually occur at temperatures ranging from 41° to 61°F (Lea 1968 and USFWS 1977, as cited in Coffin and Cowan 1995). Eggs usually hatch in approximately 4 to 6 weeks, with fry emergence occurring 13 to 23 days later. In the Maggie Creek and Rock Creek subbasins, fry always are present by July (AATA International 1998c,d; Dunham and Vinyard 1996). Fry usually move out of the tributary streams during increasing flows in the fall and winter. However, some juveniles may remain in the nursery stream for 1 to 2 years before migrating in the spring.

Numerous factors such as fires, floods, droughts, extreme temperatures, nonnative species, destructive land use practices, and habitat fragmentation have affected LCT populations within the Lahontan Basin (Dunham et al. 1997). In general, fragmentation, which results from a loss of connectivity among streams, is a concern because it reduces the recolonization potential, life history development, and habitat diversity (Dunham and Vinyard 1996). Habitat fragmentation exists in the Maggie Creek and Rock Creek subbasins. Impassable culverts beneath the county road on tributary streams are the primary cause of habitat fragmentation in the Maggie Creek subbasin. Lack of suitable habitat mainly due to intermittent or low flows is the cause of fragmentation in the Rock Creek subbasin.

### California Floater

Potential habitat for California floater, a freshwater mussel, occurs within the Maggie Creek and Rock Creek subbasins. Two live specimens were found in Maggie Creek in 1993 at the following locations: 1) immediately north of the confluence between Maggie and East Fork Cottonwood creeks, and 2) approximately mid-distance between the confluences of Cottonwood/Maggie and Jack/Little Jack creeks (Worley 1993, as cited in BLM 1993b). No live specimens were observed in surveys of the Humboldt River from Tonka downstream to Beowawe, or in Maggie, Simon, Marys, or Susie creeks (McGuire 1993). Three live California floaters also were found in a 5-mile section of lower Rock Creek Canyon in 1995 (McGuire 1995). No live or shell fragments were observed during surveys in Antelope and Boulder creeks.

Collections in Nevada have indicated that California floater occurs primarily in small, permanent streams with pool or run habitats and substrates consisting of silt, sand, and gravel (McGuire 1995). In Rock Creek, California floaters were observed in pool habitats with silt/sand substrates, depths of 18 to 30 inches, and velocities of 0.5 ft/second. One specimen also was located in a narrow run, with gravel/sand substrates, a depth of 14 inches, and velocity of 1 foot/second.

### Springsnails

Springsnails, a group of mollusks that are found in perennial springs and seeps, are considered important organisms due to their restricted distribution and native origin. Although the taxonomic classification of springsnails below the family level is difficult, Hershler (1998) has reviewed the taxonomy of *Pyrgulopsis* species. Springsnails have been collected at a limited number of springs and seeps within the Goldstrike Mine study area (see Figure 3.6-2).

Based on surveys conducted in 65 springs and seeps in 1992, springsnails were collected at 3 sites (McGuire 1992). *Pyrgulopsis* was collected in Willy Billy Spring (unnamed tributary flowing into Buck Rake Jack Creek) and Rattlesnake Spring (unnamed tributary flowing into the Humboldt River). *Pyrgulopsis bryantwalheri* was present in Warm Spring, which is located near the Humboldt River about 3 miles south of Carlin. Estimated densities at these collection sites were 200/m$^2$ at the spring source and 10/m$^2$ below the source at Warm Billy Spring, 500 to 1,000/m$^2$ at Rattlesnake Spring, and 1,000/m$^2$ at Warm Spring.

Subsequent surveys were conducted in 1995 and 1996 to include seeps and springs found within or near the Goldstrike Mine hydrological baseline study area (McGuire 1995, 1996). Springsnails (*Pyrgulopsis*) were collected in 7 of 41 springs that were surveyed (labeled in Figure 3.6-2). Collection sites included springs along Antelope Creek (T37N, R49E, Sections 5 and 8), an unnamed spring perched above Squaw Creek (T38N, R49E, Section 34), and the spring source for Hot Creek (T38N, R48E, Section 11). Hershler (1995) also reported that springsnails were common in two additional springs located within the Squaw Creek drainage (T38N, R48E, Section 33 and T40N, R47E, Section 32).

Habitat conditions in springs supporting springsnails showed the following characteristics. Springsnails usually were confined to the spring source and a wetted area immediately downstream from the spring. The springs also exhibited low to moderately high discharges (5 to greater than 30 gpm), stable substrates consisting of gravel, cobble, or boulder; and dense growth of aquatic vegetation such as

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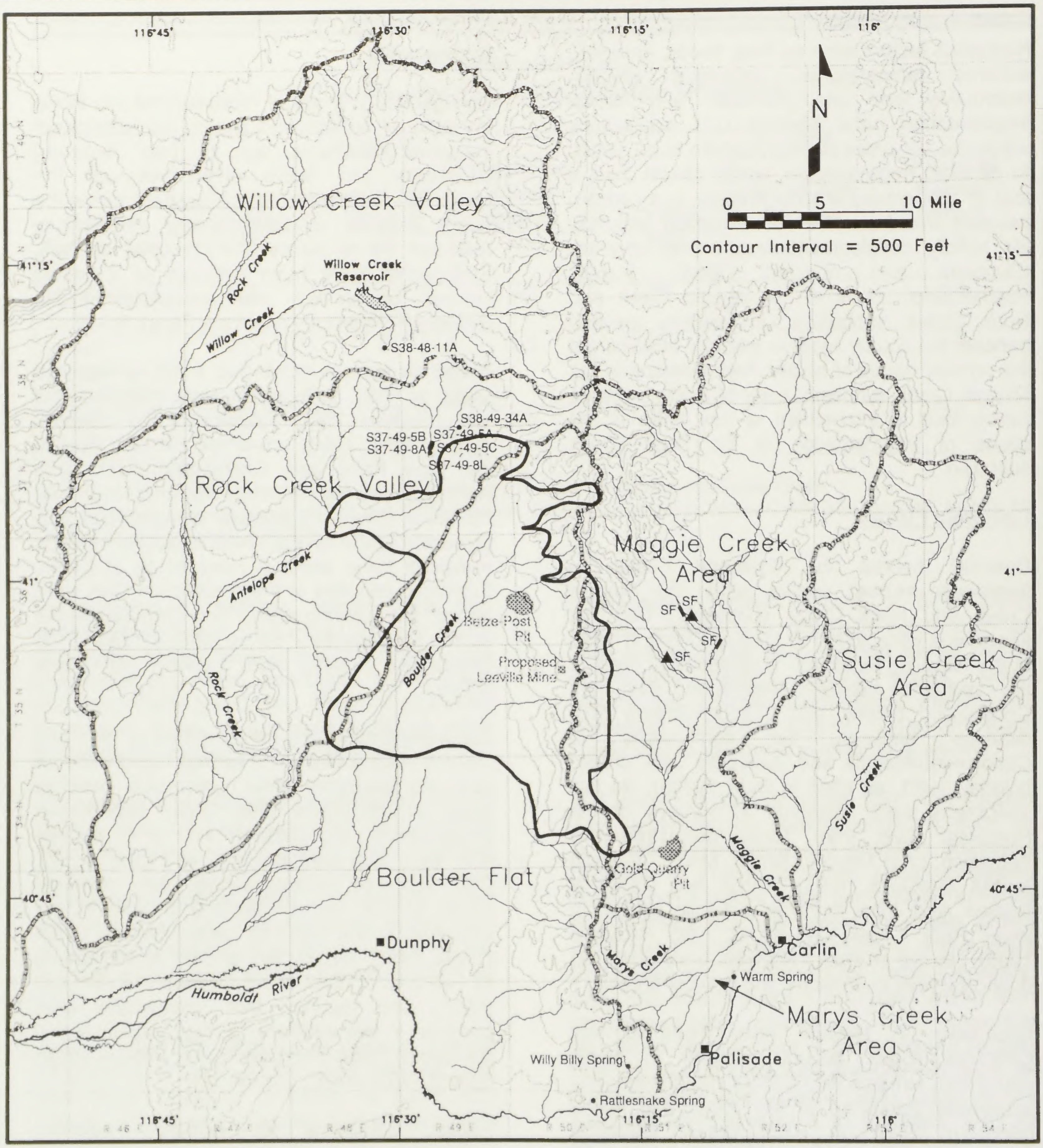

Legend

Ground Water Basin Boundary

Stream

Maximum Extent of 10-foot Drawdown Contour[1]

S37-49-8A ● Springsnail Location

SF▲ Spotted Frog Collection Sites

SF▬ Spotted Frog Potential Habitat

[1] See text in Section 3.2.2.1 for explanation

Figure 3.6-2

Known Locations for Springsnail Populations and Spotted Frog Habitat

*Ranunculus aquaticus* or *Nasturtium* (McGuire 1996, 1992). Springsnails often decline in density downstream of stream sources, presumably reflecting their requirement for stable temperature, chemistry, and flow regime (Deacon and Minckley 1974, as cited in Hershler 1998).

#### Spotted Frog

The Columbia spotted frog (Federal candidate) occurs in wetland habitats ranging from subalpine forests to low elevation shrublands and grasslands. During the breeding season, they are found near permanent water bodies such as ponds, pools in streams, and springs (BLM 1993b). The water bodies also usually contain emergent vegetation. After the breeding season is completed, frogs can move considerable distances to habitats such as mixed conifer forests, subalpine forests, grasslands, and brushlands that contain sage and rabbitbrush. This species hibernates during the winter in holes near springs or other areas where water is unfrozen and constantly renewed (U.S. Forest Service 1991). The entire upper Humboldt watershed is considered historic and potential spotted frog habitat.

The spotted frog was observed in Newmont's South Operations study area in 1992. The collection sites for this species consisted of sloughs or springs with pools that were located adjacent to Coyote and Little Jack Creeks (JBR 1992e) (see Figure 3.6-2). The spotted frog was not observed during surveys at Antelope, Rock, or Boulder Creeks in 1995 (McGuire 1996). However, a 1-mile section of Antelope Creek (T38N, R49E, Section 25) appeared to represent suitable habitat for this species. Spotted frogs were observed on the east side of the Tuscarora Mountains in Maggie Creek upstream of the Coyote Creek confluence and in old beaver ponds along Coyote Spring Creek (McGuire 1992).

## 3.6.2 Environmental Consequences

### 3.6.2.1 Terrestrial Species

Federal agencies, in consultation with the USFWS, are required to ensure that any action that they authorize, fund, or carry out is not likely to jeopardize the continued existence of a Federally listed species or species proposed for Federal listing. The BLM, as the Federal lead agency, is currently working with the USFWS under the informal Section 7 process for Barrick's water management operations.

The impact analysis pertaining to special status species focuses on only those project components or areas (e.g., water management area, Humboldt River, Humboldt Sink) that apply to special status species identified for the project. Potential short- and long-term impacts to wildlife species that may occur at the Humboldt Sink from possible exposure to constituents of concern are discussed for representative wildlife in Section 3.4.2.5. These same project assumptions and impact determinations have been applied to special status species that may use the Humboldt Sink for breeding, foraging, or resting.

#### Preble's Shrew (BLM-sensitive Species)

Little is known about the potential occurrence of the Preble's shrew in the study area (see Section 3.6.1.1). The potential long-term loss of some seeps, springs, and stream reaches within the drawdown area could reduce the amount of potentially suitable habitat for this shrew species.

As discussed for general wildlife resources in Section 3.4.2, it is anticipated that potential increased flows in the Humboldt River and Humboldt Sink would provide additional water to support existing riparian and wetland communities during the mine's discharge period. Although increased mine water discharges into the Humboldt River also would result in an increase in water withdrawals for irrigation by existing water right holders (see Section 3.2.2.2), a net increase in flows would be expected. Therefore, a short-term increase in available water for wildlife resources would be anticipated. Inundation of some wetland areas near the river may occur from greater water depths, particularly downstream of Comus (see Section 3.2.2.2). It is assumed that slightly greater inundation of some backwater areas from increased flows would occur. Inundation of terrestrial areas along the river would result in an incremental loss of habitat; however, it would be offset by the creation of other habitats along natural sloughs within existing meanders and oxbows that do not currently receive water during normal flows (see Section 3.4.2.4).

Potential impacts to species at the Humboldt Sink from chemical constituents of concern have been examined for representative wildlife species, as discussed in Section 3.4.2.5. Potential impacts to wildlife from future exposure to pit lake water quality are discussed in Section 3.4.2.3.

### Sensitive Bat Species (BLM-sensitive Species)

The impact analysis of the six special status bat species (including the two subspecies of the Townsend's big-eared bat) that may occur within the study area and along the Humboldt River focused on the changes to available foraging areas from modifying water depths and riparian vegetation. The potential reduction or loss of perennial surface water resources and surrounding riparian vegetation could affect bats, incrementally reducing the amount of suitable foraging habitat for a number of these bat species listed in Section 3.6.1.1. However, the vegetation density relative to the amount of open water combined with the proximity of possible foraging areas to occupied bat roosts would determine overall habitat values for bats and the extent of anticipated habitat losses or reduction in foraging opportunities. No impacts to bat hibernacula or other communal roosts would be anticipated, since it is assumed that these larger roost sites occur in caves, buildings, or large rock outcrops.

As discussed for other terrestrial wildlife resources, potential increased flows along the Humboldt River and Humboldt Sink would create additional foraging areas for bats, in the form of increased surface water area and improved riparian habitats. Over the life of the dewatering discharges, it is expected that a net gain of backwater habitats would occur along the river corridor.

Potential impacts to species at the Humboldt Sink from chemical constituents of concern have been examined for representative wildlife species, as discussed in Section 3.4.2.5. Potential impacts to wildlife species from future exposure to pit lake water quality are discussed in Section 3.4.2.3.

### Bald Eagle (Federally Threatened; Delisting Pending)

The reduction in perennial surface water within the drawdown area would incrementally reduce the potential amount of available foraging habitat for wintering and migrating eagles. However, potential habitat effects would be minimized, based on: (1) the low number of wintering eagles that typically occur within the regional hydrologic study area (i.e., two to six eagles within each of the subbasins, Rock Creek, Boulder Creek, and Maggie Creek); (2) the fact that wintering and migrating birds use both open water areas and the upland habitats for foraging; (3) no drawdown impacts are anticipated for the Willow Creek Reservoir, a prominent site for eagles; (4) no known communal or historic roost sites occur within this study area; and (5) the committed protection measures summarized in Section 1.6 of this SEIS.

Potential effects to bald eagles that occur along the Humboldt River and Humboldt Sink during the mine's water discharges would parallel the effects discussed for general wildlife resources. Increased water levels would be most apparent during the low-flow periods (October through February), resulting in more open water (less freezing) during the late fall and winter and a greater prey abundance.

As discussed above, the potential for adverse impacts to species using the Humboldt Sink from possible bioconcentration of chemical constituents of concern is discussed in Section 3.4.2.5. Potential impacts to wildlife species from future exposure to pit lake water quality are discussed in Section 3.4.2.3.

### Golden Eagle (Nevada-listed Species)

Potential impacts to the golden eagle that could occur from the reduction or loss of riparian or wet meadow habitat types would be limited to an incremental reduction in potential foraging areas, if available surface water and associated riparian vegetation were affected by long-term ground water drawdown. However, this raptor predominantly nests and forages in drier, upland areas, and use of riparian drainages and wet meadow areas would be incidental. The potential effects to golden eagles from increased water levels in the Humboldt River and in the Humboldt Sink would parallel those discussed for general wildlife resources in Section 3.4.2.4 and 3.4.2.5, respectively. An overall increase in water availability and maintenance or enhancement of riparian vegetation would result in an associated increase in small mammal populations. Therefore, an incremental increase in the quality of foraging habitat and opportunities along the river and in the Humboldt WMA could be anticipated, even with an increase in water use for irrigation purposes.

### Northern Goshawk (Nevada-listed Species)

Potential long-term effects to the northern goshawk could result from reduction or loss of riparian habitats associated with perennial water sources at the higher elevations of the Tuscarora Mountains. Possible impacts to nesting and foraging goshawks would be limited to perennial water sources that are hydraulically connected to the regional ground water system and that support suitable trees for goshawk nest sites and sufficient vegetation for this accipiter's primary prey species. Generally, the northern goshawk preys upon smaller birds; however, the forage composition for goshawks in the Independence Range has been documented as 67 percent ground squirrels (NDOW 2000). The potential effects from changing flows in the Humboldt River and Humboldt Sink would only apply to wintering goshawks, since the Humboldt River Valley occurs at elevations that are lower than those typically occupied by nesting goshawks.

The potential for impacts to individuals using the Humboldt Sink from possible bioconcentration of chemical constituents of concern is discussed in Section 3.4.2.5. Potential impacts to wildlife species from future exposure to pit lake water quality are discussed in Section 3.4.2.3.

### Swainson's Hawk (Nevada-listed Species)

The likelihood of Swainson's hawks nesting and foraging within the study area is low, based on this species' current distribution in northern Nevada (see Section 3.6.1.1). If nesting and migrating birds were present, potential impacts to breeding or foraging birds would parallel the discussions for the other special status raptor species (i.e., ferruginous hawk, golden eagle, northern goshawk). Since this hawk species may occupy both upland and riparian areas for nesting and foraging, a potential reduction in available water and/or riparian vegetation could incrementally impact this species' nesting sites and foraging areas. A reduction in potential prey abundance (from invertebrates to small vertebrates) may affect this species' distribution and habitat use in northern Nevada, if present. Potential impacts to the Swainson's hawk from increased water flows into the Humboldt River and Humboldt Sink would be the same as those discussed for general wildlife and special status raptor species. Increased water levels and riparian habitats could result in a correlated increase in potential prey species for both breeding and migrating individuals.

The potential effects to individual birds using the Humboldt Sink from possible bioaccumulation factors are discussed in Section 3.4.2.5. Potential impacts to wildlife species from future exposure to pit lake water quality are discussed in Section 3.4.2.3.

### Ferruginous Hawk (Nevada-listed Species)

The long-term reduction or loss of riparian habitats may indirectly affect this raptor species. The success of nesting raptors is often closely associated with the available prey base and relative prey densities, and prey availability is particularly important for nesting ferruginous hawks. Also, because concentrations of ferruginous hawks have been documented using wet meadows in the study area as staging areas prior to fall migration, prey abundance in these wet meadow habitat types may be important to both migrating and nesting birds. Reduction or loss of wet meadow or riparian habitats from drawdown effects could remove habitats for suitable prey, thereby reducing prey abundance and possibly affecting subsequent ferruginous hawk nesting success.

As discussed for other sensitive species, increasing flows within the Humboldt River and Humboldt Sink may increase relative prey bases for area predators during the mine's discharges. For the ferruginous hawk, increasing prey species would be small mammals that may commonly occupy wet meadow or mesic habitats. A possible increase in these small mammal populations from increasing and expanding riparian habitats would likely be utilized by foraging raptors, including the ferruginous hawk.

The potential for impacts to individual birds using the Humboldt Sink from possible bioconcentration of chemical constituents of concern is discussed in Section 3.4.2.5. Potential impacts to wildlife species from future exposure to pit lake water quality are discussed in Section 3.4.2.3.

### Osprey (Nevada-listed Species)

No impacts to the osprey would be anticipated from the potential long-term reduction in available surface water seeps, springs, or small streams throughout the study area, since this rare migrant generally is associated with large reservoirs, lakes, and rivers. As discussed for the bald eagle, no effects to Willow Creek Reservoir are expected, and the possibility of individual migrating osprey foraging along the smaller creeks or springs is low. The potential increase in available water in the Humboldt River during the mine's discharge period may result in increased foraging opportunities for migrating individuals. The potential bioaccumulation effects discussed for species foraging within the Humboldt WMA in the long term are presented in Section 3.4.2.5.

### Burrowing Owl (Nevada-listed Species)

Based on this owl species' known habitat associations, it is assumed that breeding adults and young predominantly occupy dry, upland communities. However, it could not be determined, based on a preliminary literature review, whether burrowing owls depend on open (free) water or riparian/mesic habitats for foraging. Therefore, a conservative impact analysis for the burrowing owl would be limited to possible long-term loss of available water and possible foraging areas along riparian or wet meadow habitats. Since mesic and riparian habitats often provide a greater diversity and abundance of terrestrial invertebrates, it is feasible that adult owls would forage within these areas, particularly during the brood-rearing period. No impacts to this species' dry, upland nesting habitats would be anticipated. Potential impacts to the burrowing owl from changing water levels in the Humboldt River would be expected to be limited to an incremental increase in possible foraging habitat. However, based on this species' typical nest site selection, use of the river corridor likely would be sporadic and isolated.

### Sage Grouse (BLM-sensitive Species)

A potential reduction in naturally occurring seeps, springs, and perennial stream reaches and their associated riparian and mesic communities could ultimately affect the amount of potential brooding and foraging habitat for sage grouse. This incremental habitat loss would be long-term, and it is assumed that the birds that are closely associated with these habitat types would be displaced.

For perspective of potential long-term impacts to sage grouse, available data from the NDOW's statewide sage grouse lek database and the additional data collected by JBR (1992g) within Barrick's drawdown area were compiled for both the drawdown area and within 2 miles of this drawdown area where the highest likelihood of nesting may occur away from the leks.
A quantitative summary of historic lek sites in and near the drawdown area was generated to characterize the overall use of the region by sage grouse. A total of four historic leks have been documented within the drawdown area, including three in the Little Boulder Basin and one in the Tuscarora Mountains. Of these four leks within the drawdown area, three are located in areas where perennial surface waters potentially could be affected. An additional three leks have been documented within 2 miles of the drawdown area boundary (NDOW 1998c; JBR 1992g).

In the event that perennial flows were reduced, the riparian vegetation would likely decrease, reducing the vegetative structure, composition, and diversity. No direct impacts to active or potential lek sites would be anticipated, since leks generally occur in more upland communities (although they are often adjacent to intermittent or perennial drainages). However, there is a potential that nesting and brood-rearing areas could be affected in riparian, wetland, and mesic habitats that could be impacted by ground water drawdown, particularly in the mid to late summer, as the upland forbs desiccate and the broods depend more on the mesic and riparian habitats. Because these brood-rearing areas could be located several miles from leks and nesting areas within the drawdown area, it is difficult to quantify the amount of habitat that could be affected. However, it can be stated that the loss of riparian, wetland, or mesic habitats due to drawdown in these areas would reduce the amount of possible nesting and brood-rearing habitat available, altering sage grouse distribution during summer and autumn and possibly reducing the total sage grouse population.

As stated above, this summary has been generated to aid in characterizing the overall distribution and concentration of active lek sites for the assessment area. It is unknown whether specific lek sites and their associated nesting and brooding habitats may be affected in or near the drawdown area shown in Figure 3.2-25; however, it is feasible that the water drawdown may impact riparian, wetland, and mesic habitats used by nesting and brooding hens. As discussed in Section 3.3.2.1, the potential effects to riparian and wetland habitats total an estimated 150 acres within the area of potential impact (see Figure 3-15). The estimated acres of riparian habitat and wetland areas equal 137 and 13, respectively, which total the 150 acres; however, mesic habitats are not included in this acreage estimate. Given the variables discussed in Section 3.2.2.1, the dated and scattered available information on active lek sites, and the recent habitat loss from extensive wildfire events in northern Nevada, it is difficult, if not impossible, to estimate the percentage of these riparian or wetland areas that are actually used by nesting or brooding sage grouse and the amount of mesic habitat that could be affected. Therefore, the total number of acres of potentially suitable breeding, nesting, or brooding habitats that could be either directly or indirectly impacted in the long term cannot be quantified.

#### American White Pelican (Nevada-listed Species)

As discussed for the osprey and bald eagle, no impacts to large bodies of water (e.g., Willow Creek Reservoir) are currently anticipated that could support pelican foraging. Since this species is closely associated with lakes or ponds, no impacts to migrating pelicans would be anticipated from future changes in water levels or riparian habitats in the mine areas or along the Humboldt River. The potential effects to fish-eating birds from possible bioaccumulation of constituents of concern in the Humboldt Sink area are presented in Section 3.4.2.5.

#### White-Faced Ibis (Nevada-listed Species) and Black Tern (BLM-sensitive Species)

The long-term impacts to these two shorebird species within the study area focused on potential long-term effects to naturally occurring water sources and the ultimate reduction in available habitat associated with the artificially created wetlands within Boulder Valley. If present, individual birds would likely use the larger spring sites in the foothills region of the mountain ranges and the perennial portions of streams that support adequate riparian habitat and pools for foraging and cover. The reduction or loss of available surface water and associated emergent plants in these naturally occurring wetland areas could result in the displacement or loss of breeding or foraging individuals, if present. As discussed for other wildlife species (see Section 3.4.2), it is assumed that the riparian communities potentially affected by the mine's dewatering activities are currently at their respective carrying capacities, given their limited availability in the assessment area. Therefore, loss of surface water and the associated riparian vegetation at historically occupied wetland areas would result in the displacement and/or loss of the individual birds dependent on these resources. This loss may affect the breeding potential of individuals; however, no population-level impacts would be anticipated. The estimated acreages of riparian and wetland habitats that could be affected in the long term are presented in Section 3.3.2.1. Given the variables involved, it is not possible to quantify potential impacts to individual birds or breeding pairs.

As discussed for general water bird species in Section 3.4.2, as the mine discharges diminish in the future, the artificially created wetlands in Boulder Valley would be reduced, as well. The level of available surface water, in addition to the associated riparian and wetland vegetation, would slowly decline, with the drier, more upland communities becoming re-established. However, it presently appears that previously saturated soils have increased soil leaching of salts and minerals. This leaching process would ultimately result in a transition of the present plant communities to a community that supports more salt-tolerant plants. This transition would result in both decreased plant and wildlife species diversity. The dry alkaline soils and more upland vegetation would not be suitable for use by either the white-faced ibis or black tern.

As discussed for other terrestrial species, increased flows in the Humboldt River and in the Humboldt Sink during the mine's discharges would result in an increase in potentially suitable habitat for these two water birds. Following Barrick's dewatering operations, water levels in the sink would be anticipated to return to premining levels, and the resulting incremental loss of habitat along the margins of the sink would be offset by the creation of habitats along the margins of the sink at the new (i.e., premining) water level. The potential for impacts to species breeding and foraging in the Humboldt Sink from possible exposure to chemical constituents of concern is discussed in Section 3.4.2.5.

#### Nevada Viceroy (BLM-sensitive Species)

Because the Nevada viceroy is associated with willows below 6,000 feet elevation, surface water reductions that would affect the maintenance of willow communities would reduce the amount and quality of habitat for this species. Therefore, reduced flows may reduce willow development, which would affect Nevada viceroy habitat. Increased flows in the Humboldt River due to mine-water discharges could increase riparian habitat (and associated Nevada viceroy habitat) during mine discharge.

#### Lewis Buckwheat

Impacts to Lewis buckwheat are not anticipated as a result of ground water drawdown since this species is associated with upland habitats and is dependent on seasonal precipitation.

### 3.6.2.2 Aquatic Species

#### Lahontan Cutthroat Trout

Drawdown would not affect flows or water quality in streams that support existing populations or potential habitat for LCT. These streams include Little Jack, Coyote, Jack (Indian), Beaver, Little Beaver, Toro Canyon, and Williams Canyon in the Maggie Creek subbasin and Frazer, Willow, Toe Jam, Nelson Lewis, and Rock creeks in the Rock Creek subbasin. In addition, other water management activities pertaining to the pit lake development would not affect water quality in these streams. Since flows or water quality would not be affected in these streams, Barrick's water management operations would not impact LCT.

#### California Floater

Potential habitat for the California floater exists in Maggie Creek (near the Cottonwood Creek confluence and the Jack/Little Jack confluences) and Rock Creek (Rock Creek Canyon). Drawdown would not affect flows or water quality in the Maggie Creek subbasin or Rock Creek.

#### Springsnails

Springsnail populations are known to occur in upper Antelope Creek (six locations) and upper Willow Creek (one location) (see Figure 3.6-2). No populations have been found in the Maggie Creek or Boulder Creek subbasins or the remaining portions of the Rock Creek watershed. Three populations also exist in springs near the Humboldt River. Drawdown may reduce water levels in springs and perennial reaches in Upper Antelope Creek. If substantial water level reductions occurred in these springs, springsnail populations could be adversely affected. Drawdown would not affect springs in the Upper Willow Creek area, where one known population exists.

#### Spotted Frog

The spotted frog has been collected in Maggie Creek upstream of the Coyote Creek confluence, Coyote Spring Creek, Little Jack Creek, and Coyote Creek. Potential habitat also was identified in a 1-mile section along Upper Antelope Creek (see Figure 3.6-2). No spotted frogs or potential habitat were observed in the Boulder Creek subbasin or remaining portions of the Rock Creek subbasin. Drawdown would not affect perennial reaches in the Maggie Creek subbasin where populations have been reported. Potential spotted frog habitat may be adversely affected in Upper Antelope Creek, if water levels were reduced in perennial reaches.

## 3.6.3 Monitoring and Mitigation

### 3.6.3.1 Sage Grouse

In addition to the monitoring or mitigation measures that have been identified for terrestrial wildlife in Section 3.4.3, the following measure for sage grouse has been developed. To mitigate the potential long-term loss of sage grouse nesting and brooding habitat in the project area, funds would be established for off-site habitat rehabilitation from past wildfire effects for native sagebrush lands. The amount of this fund would be negotiated between the BLM and Barrick, and habitat improvement would aid in mitigating the potential reduction in riparian and mesic communities from Barrick's dewatering and water management operations. This measure would be in addition to the improvements planned for the Squaw Creek Allotment, as discussed in Section 3.4.3.

### 3.6.3.2 Spotted Frog

Potential habitat for the spotted frog has been identified in the upper Antelope Creek drainage. As discussed for native fish species, flow monitoring would continue in the upper Antelope Creek drainage to determine if dewatering activities affect potential habitat to the spotted frog. Refer to Section 3.2.1.2 for a description of the existing surface water flow monitoring program.

If flow is reduced compared to baseflow conditions during the low-flow period in upper Antelope Creek, BLM would determine the need for mitigation. If required, mitigation for the spotted frog would be the same off-site enhancement described for native fish (see Section 3.5.3). By improving riparian vegetation and streambank stability in upper Rock, Toe Jam, and upper Willow Creek, habitat would be enhanced in areas considered to be potential habitat for this species.

### 3.6.3.3 Springsnails

Springsnail populations are known to occur in springs and seeps in upper Antelope Creek and Squaw Creek, which could be affected by dewatering activities. An important part of monitoring for springsnails is to conduct an inventory in suitable habitat to determine the presence of this group of invertebrates within the potentially impacted area. The previous survey conducted by McGuire (1996) inventoried most of the springs and seeps considered to be suitable habitat in this area. However, McGuire's survey did not survey all springs and seeps in the area potentially impacted by Barrick's dewatering activities. The location and abundance of springsnails would be documented and mapped. In addition to the inventory, water levels would be monitored in springs and seeps known to contain springsnails. Based on McGuire's 1996 survey, monitoring would be conducted in the following springs or seeps in upper Antelope Creek: 37-49-5A, 37-49-5B, 37-49-5C, 37-49-8A, and 37-49-8L (see Figure 3.6-2 for the locations of these springs). Monitoring also would be conducted in one spring in Squaw Creek designated as 38-48-34A.

If water levels are reduced in any of these springs, mitigation would be implemented for springs. Mitigation options for springsnails would include flow augmentation, relocation of springsnails, on-site habitat enhancement, or off-site habitat enhancement. Flow augmentation would involve water input into groundwater or surface water that would increase water levels in the six springs listed above. Of these, spring 37-49-8L represents the highest priority spring, since it contained a relatively large population of springsnails. A second option would be to relocate smaller springsnail populations from potentially impacted springs to suitable off-site habitat. The relocation site must not contain other endemic springsnail species, since taxonomy issues have not been resolved at this time.

On-site habitat enhancement would involve fencing around the six springs to reduce grazing activity. Important information to be considered in fencing would include: (1) probability of future dewatering activities that could affect these springs, (2) fencing projects must be coordinated with private land owners, and (3) water must remain available to livestock outside the fenced area either through a pipeline/trough system or fencing design. Off-site enhancement would consist of fencing at other sites that support springsnails, which are located outside of the potential impact area. Potential sites include the spring source for Hot Creek (tributary to Willow Creek Reservoir) and several springs north of Willow Creek Reservoir.

### 3.6.4 Residual Effects

The residual impacts to sensitive terrestrial wildlife species would be the same as discussed for general wildlife resources in Section 3.4.4. Residual effects could occur for three of the four sensitive aquatic species. There would be no residual impacts to LCT. Residual impacts may occur for springsnails, if flow augmentation is not implemented. Loss of perennial reaches in upper Antelope Creek would be a residual impact to potential habitat for spotted frog.

### 3.6.5 Irreversible and Irretrievable Commitment of Resources

No irreversible commitment of resources would be anticipated for special status wildlife species associated with this project. However, the loss or long-term reduction in available water, riparian and wetland habitats, or perennial stream reaches would be considered an irretrievable commitment of resources for the Preble's shrew; six sensitive bat species; wintering or migrating bald eagles; foraging golden eagles and burrowing owls; nesting or foraging northern goshawks, Swainson's hawks, and ferruginous hawks; nesting and brooding sage grouse; breeding or migrating white-faced ibis and black tern; and habitat for the Nevada viceroy.

The loss of aquatic habitat in upper Antelope Creek (springs, seeps, and perennial reaches) would be an irreversible and potentially irretrievable impact for spotted frog (potential impact) and springsnails, if the water bodies dry up and flow augmentation is not used as mitigation. In addition, loss of aquatic habitat in lower Rock Creek would be an irreversible and irretrievable impact, if flow augmentation is not implemented. Off-site enhancement involving improved land use practices in the Squaw Valley Allotment could offset some of these impacts.

## 3.7 Grazing Management

### 3.7.1 Affected Environment

The study area for grazing management comprises the hydrologic study area described in Section 3.2.1, Water Resources and Geochemistry, Affected Environment. The study area (Figure 3.7-1) primarily consists of public and privately-owned rangeland that is used for livestock grazing and provides habitat for a variety of wildlife species (see Section 3.4.1). Smaller parcels of private property that have been disturbed by mine development or are used as irrigated pastures and cropland also are present within the study area. A large parcel of private property, located in the southern portion of Boulder Valley, is owned and operated by the ELLCO.

Portions of 16 grazing allotments are located in the study area (Table 3.7-1) including the Squaw Valley, Tuscarora/Quarter Circle S, Twenty-five, Boulder Field, T Lazy S, Hadley, Carlin Canyon, Carlin Field, McKinley, Blue Basin, Lone Mountain, Adobe, Adobe Hills, Marys Mountain, Palisade, and Horseshoe allotments. Pastures, permittee(s), permitted active grazing use for public land, percent public land, numbers and kinds of livestock, general season of use, and type of operation for each allotment area are provided in Table 3.7-1. For most of these allotments, public land provides 36 to 86 percent of the livestock carrying capacity. The Blue Basin, McKinley Fenced Federal Range (FFR), and Carlin Canyon allotments consist primarily of private lands with smaller parcels of public land.

The permitted active grazing use (i.e., animal unit months [AUMs]) provided in Table 3.7-1 is for BLM-administered land only and does not account for private lands within each allotment. Cow-calf operations are the most prevalent grazing operations in the study area. The Ellison Ranching Company is the only permittee that manages a ewe/lamb operation within the study area in addition to a cow-calf operation.

Three grazing allotments are located within the area potentially affected by Goldstrike Mine dewatering, including the Twenty-five, Boulder Field, and T Lazy S allotments. Grazing operations in the Twenty-five allotment are managed by the 26 Corporation. The permitted active grazing use on the public land within this allotment is 34,130 AUMs, of which 33,281 AUMs are in areas of the allotment in which public land provides 61 percent of the livestock carrying capacity, and the remaining 849 AUMs are in a fenced parcel that includes some public land. Dean and Sharon Rhoads manage grazing in the Boulder Field allotment, in which public land provides 51 percent of the livestock carrying capacity. The public land provides 838 AUMs within the allotment.

The ELLCO personnel manage grazing operations within the T Lazy S and Marys Mountain grazing allotments and private land in Boulder Valley as one general grazing unit (Gralian 1998). The permitted active grazing use on the public land within this allotment is 11,999 AUMs, of which 11,797 AUMs are in areas of the allotment in which public land provides 44 percent of the livestock carrying capacity, and the remaining 202 AUMs are in a fenced parcel that includes some public land. Approximately 4,000 cow-calf pairs are used to graze rangeland within these allotments and the private land in Boulder Valley. In addition to the cow-calf pairs, yearlings are allowed to graze in Boulder Valley if an adequate amount of forage is available on irrigated pasture and alfalfa fields during the summer. Cows and replacement heifers are wintered in Boulder Valley and typically graze residual forage in the alfalfa fields, barley fields, irrigated pastures, and native rangeland. The irrigated pastures predominantly consist of introduced grasses including smooth brome and orchardgrass.

Some of the water produced from Barrick's dewatering activities is used for irrigation and livestock watering in Boulder Valley. Water used to irrigate approximately 10,000 acres of land for the production of alfalfa, barley, and introduced pasture grasses and provide water to grazing livestock is conveyed via pipelines (Gralian 1998). Irrigated pastures that support introduced grasses are grazed annually.

A livestock exclusion fence has been constructed around the wetland area at Green, Knob, and Sand Dune springs in Boulder Valley to prevent grazing of approximately 1,000 acres of riparian vegetation. This area is a separate pasture within the allotment. As mentioned above, ELLCO manages the T Lazy S allotment, of which the Betze Post Mine Area and Central Native

## Table 3.7-1
## Grazing Allotments in the Study Area

| Allotment | Permittee(s) or Operator(s) | Public Land Permitted Active Grazing Use (AUMs)[1] | Percent Public Land | Number(s) and Kind(s) of Livestock | General Season of Use | Type of Operation |
|---|---|---|---|---|---|---|
| **Squaw Valley** | Ellison Ranching Company | 26,654<br>142 | 77<br>100 (FFR)[2] | 7,081 cattle; 8,375-9,600 ewes; 27 horses<br>12 cattle | March 16 to November 30<br>Yearlong | Commercial cow/calf; ewe/lamb |
| **Tuscarora/Quarter Circle S** | Van Norman Ranches, Inc. | 5,068<br>117 | 96-100<br>100 (FFR)[2] | 1,455 cattle; 2 horses | April 1 to December 15; Yearlong | Commercial cow/calf |
|  | Dean and Sharon Rhoads | 8,646<br>511 | 54-100<br>100 (FFR)[2] | 2,202 cattle<br>850 cattle | April 1 to December 15; Yearlong | Commercial cow/calf and horses |
| **Twenty-five** | 26 Ranch Corporation | 33,281<br>849 | 61<br>100 (FFR)[2] | 4,530 cattle; 40 horses<br>861 cattle | Yearlong for cattle and horses<br>May 1 to May 30 | Commercial cow/calf |
| **Boulder Field** | Dean and Sharon Rhoads | 838 | 51 | 543 cattle | March 1 to May 31 | Commercial cow/calf |
| **T Lazy S** | Elko Land and Livestock Company | 11,797[3]<br>202 | 44<br>100 (FFR)[2] | 2,718 cattle;<br>350 cattle | February 15 To November 30; Yearlong | Commercial cow/calf |
| **Hadley** | Maggie Creek Ranch LP | 4,276<br>206 | 49<br>100 (FFR)[2] | 1,119 cattle<br>202 cattle | April 1 to December 20; Yearlong | Commercial cow/calf |
| **Carlin Canyon FFR** | Maggie Creek Ranch LP | 51 | 100 | 34 cattle | May 1 to June 15 | Commercial cow/calf |
| **Carlin Field** | Maggie Creek Ranch LP | 2,442 | 100 | 335 cattle | April 1 to December 20 | Commercial cow/calf |
| **McKinley FFR[3]** | Maggie Creek Ranch LP | 727 | 100 | 91 cattle | April 1 to November 29 | Commercial cow/calf |
| **Blue Basin** | Heguy Ranches, Inc. | 4,265 | 96 | 584 cattle; 9 horses | April 1 to November 15 | Commercial cow/calf |

## Table 3.7-1 (Continued)
## Grazing Allotments in the Study Area

| Allotment | Permittee(s) or Operator(s) | Public Land Permitted Active Grazing Use (AUMs)[1] | Percent Public Land | Number(s) and Kind(s) of Livestock | General Season of Use | Type of Operation |
|---|---|---|---|---|---|---|
| **Lone Mountain** | Hooper, Scott, Mark, Kirk, Lili Wolf, and Jennifer Garret | 7,202 | 64 | 1,546 cattle;<br>2,000 cattle;<br>1,000 cattle | April 15 to July 15;<br>July 15 to September 30;<br>October 1 to November 15 | Commercial cow/calf |
| **Adobe** | Bruce Miller | 526 | 86 | 221 cattle | April 16 to October 15 | Commercial cow/calf |
| **Adobe Hills** | Samuel Layton | 2,208 | 61 | 696 cattle;<br>10 horses | April 1 to October 30 | Commercial cow/calf |
| **Marys Mountain** | Elko Land and Livestock Company | 1,408 | 51 | 324 cattle | February 15 to October 31 | Commercial cow/calf |
| **Palisade** | Palisade Ranch, Inc. | 1,335 | 47 | 443 cattle | April 16 to October 27 | Commercial cow/calf |
| **Horseshoe** | Zeda, Inc. | 1,489<br>140 | 36-46<br>100 (FFR)[2] | 595 cattle<br>200 cattle | March 10 to September 30;<br>Yearlong | Commercial cow/calf |

Source: BLM grazing leases.

[1] An animal unit month (AUM) is the amount of forage required to sustain one cow/calf pair for a 1-month period.

[2] FFR= Fenced Federal Range.

[3] 1,202 AUMs have been suspended due to wild fires that occurred in 1999. This figure (11,979 AUMs) does not reflect this suspension.

pastures are located within the predicted 10-foot drawdown area.

The MCWRP (see Section 3.3) was implemented in 1993 and includes a total of 16 pastures, which are located in the T Lazy S allotment (see Figure 3.7-1). A summary of the MCWRP grazing management activities and riparian habitat conditions within these pastures is provided in Section 3.3, Riparian Vegetation.

Range improvements within the study area include livestock water sources (e.g., improved springs, stock wells, stock ponds, water pipelines, and troughs), fences, seeded rangeland, and cattle guards. Water sources are critical to grazing operations since livestock require water daily; the location of these water sources directly affects the distribution of livestock within an allotment. Livestock water sources include water-related range improvements and natural perennial water sources (i.e., perennial stream reaches, springs, and seeps). Figure 3.7-2 illustrates water-related range improvements, allotment boundaries, and pasture boundaries within or adjacent to the predicted drawdown area. Table 3.7-2 lists the water-related range improvements according to grazing allotment and pasture within or adjacent to the predicted Goldstrike Mine ground water drawdown area (Figure 3.7-2). In addition to water-related range improvements, natural perennial water sources present within or adjacent to the predicted drawdown area are illustrated in Figure 3.7-3.

The Humboldt River is used as a source of water for livestock grazing operations on private and BLM-administered lands within the study area. However, the river does not supply water to livestock within the allotments that may be affected by drawdown. Riparian and wetland vegetation associated with the river and adjacent wetlands has been subjected to grazing for many years. In the early 1990s, NDOW conducted wildlife habitat evaluations at various ranches extending from the Dunphy discharge point to Rye Patch Reservoir. Information from these evaluations indicated that the majority of the riparian habitats evaluated were in good condition although some were in fair or poor condition as a result of livestock grazing and flooding (Bradley 1992). No livestock grazing occurs in the Humboldt Sink and Carson Sink areas because they are associated with the Humboldt and Stillwater Wildlife Management Areas, respectively.

## 3.7.2 Environmental Consequences

### 3.7.2.1 Impacts from Mine Dewatering and Localized Water Management Activities

Ground water drawdown resulting from mine-related dewatering activities may affect various water sources used by livestock including improved springs, natural springs, seeps, and perennial stream reaches. Table 3.7-2 indicates in bold type the eight water-related range improvements that could be affected by Goldstrike Mine dewatering. Figures 3.7-2 and 3.7-3 illustrate the water-related range improvements and natural perennial water sources that potentially could be affected by ground water drawdown. Impacts are anticipated only for those water sources that are hydrologically connected with the regional ground water system. No impacts to water sources that obtain water from perched or localized aquifers are anticipated. Only stock ponds associated with seeps or springs connected to the regional ground water system potentially could be affected. Water troughs and pipelines associated with improved springs or stock wells also could be affected.

Impacts that may occur as a result of ground water drawdown include reduced flow or complete cessation of flow from water sources. The long-term loss of water sources would result in the reduction or loss of permitted active grazing use within a grazing allotment if alternative water sources are not present within the vicinity of the affected water sources or if loss of water sources is not mitigated. The reduced flow or change in water source from perennial to intermittent would result in a reduction in season of use or affect livestock distribution, which also would affect perennial active grazing use. Drawdown impacts could be localized to water sources within one or several allotment pastures. The loss of the majority or all water sources within these pastures would likely affect livestock distribution, forage utilization, and grazing management operations.

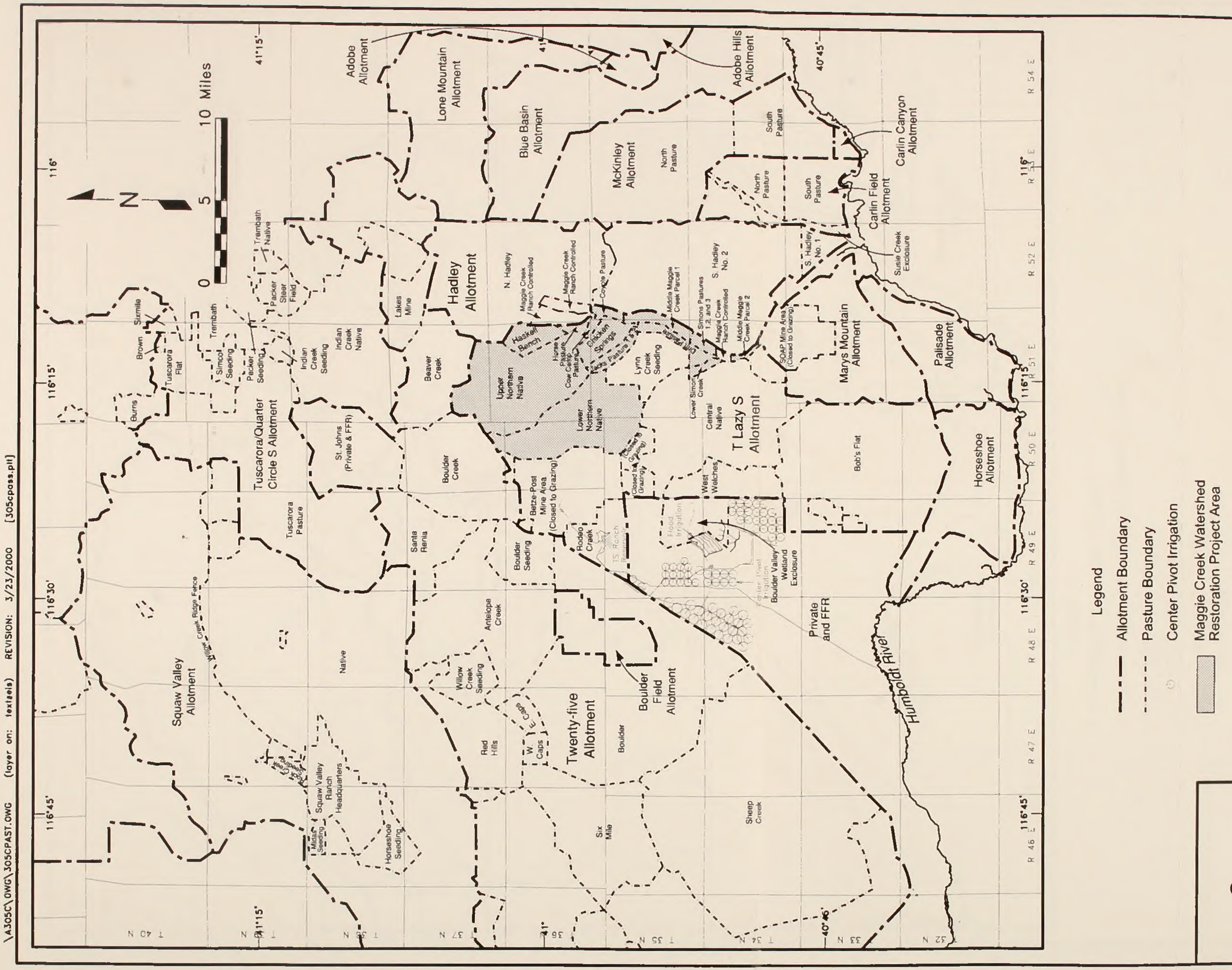

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Figure 3.7-1

Grazing Allotments and Pastures

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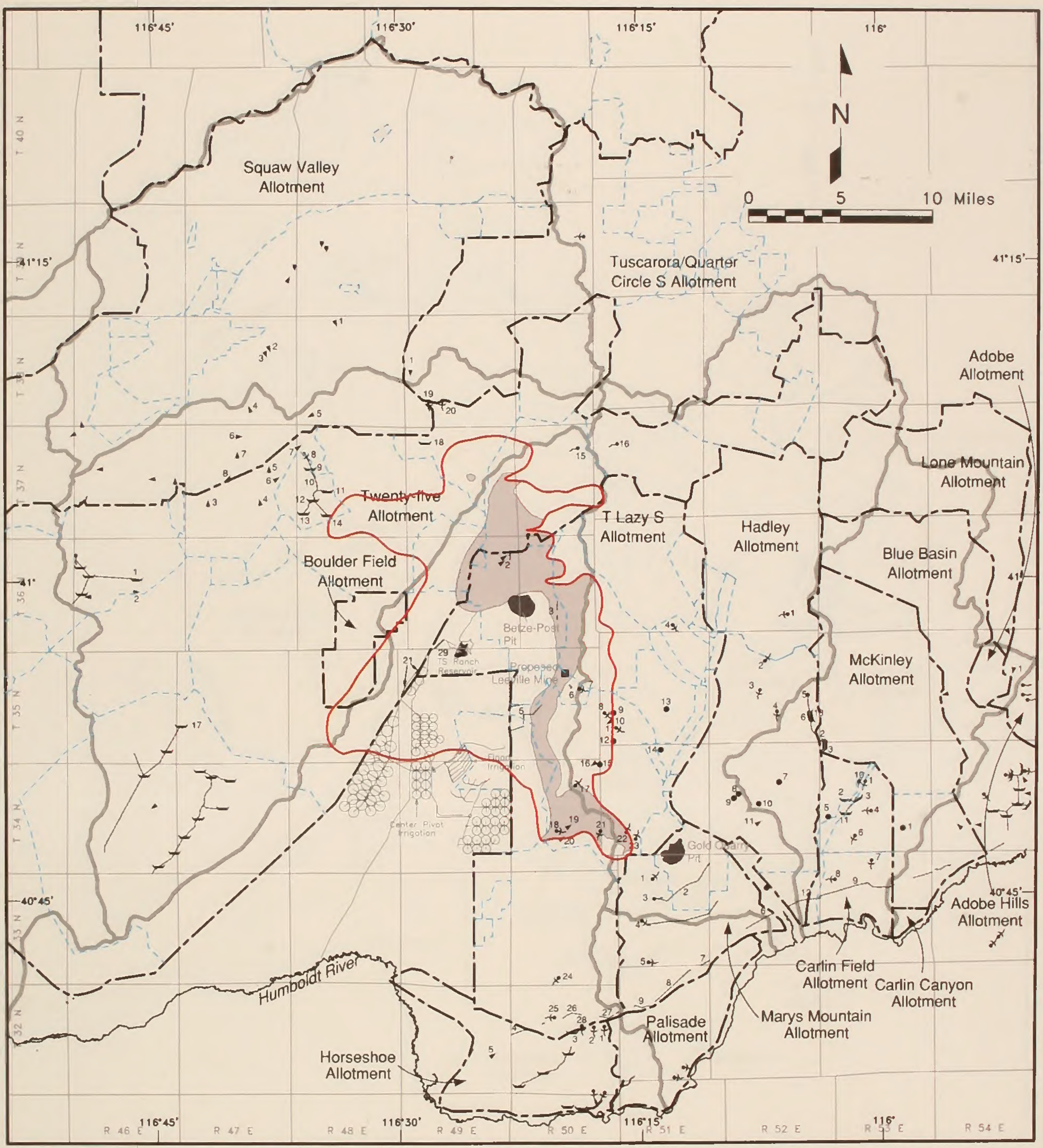

Legend

- Ground Water Basin Boundary
- Maximum Extent of 10-foot Drawdown Contour[1]
- Allotment Boundary
- Pasture Boundary
- Existing Water Pipeline
- Water Trough
- Stock Pond
- Spring
- Improved Spring
- Stock Well
- Areas where Perennial Waters could Potentially be Impacted by Drawdown[2]
- Areas where Perennial Waters have a Low Probability of Being Impacted by Drawdown[2]
- Center Pivot Irrigation

See Table 3.7-2

[1] See text in Section 3.2.2.1 for explanation

[2] Does not include potential impacts to perennial waters located outside the 10-foot drawdown contour.

Figure 3.7-2

Grazing Allotments and Water-related Range Improvements

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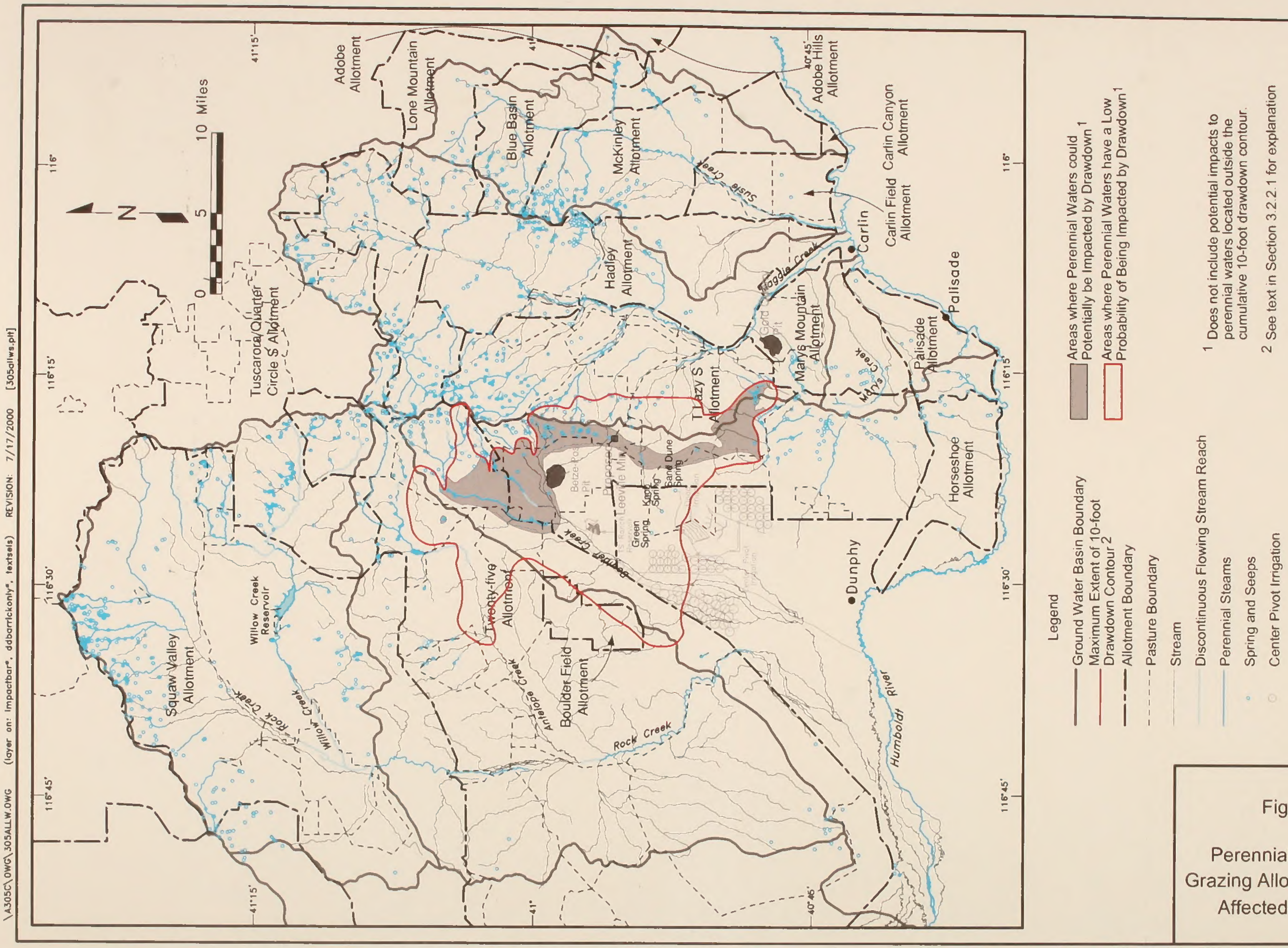

[1] Does not include potential impacts to perennial waters located outside the cumulative 10-foot drawdown contour.

[2] See text in Section 3.2.2.1 for explanation

Figure 3.7-3

Perennial Waters Within Grazing Allotments Potentially Affected by Drawdown

Table 3-7.2
Water-related Range Improvements Within the 10-foot Drawdown Contour

| Grazing Allotment | Pastures | Water Source Number[1] | Water Source Type | Legal Description |
|---|---|---|---|---|
| Twenty-five | Unknown | 1 | Water pipeline and trough | T36N, R46E |
| | Six Mile | 2 | Stockwater pond | T36N, R46E |
| | Red Hills | 3 | Stockwater pond | T37N, R47E |
| | Red Hills | 4 | Stockwater pond | T37N, R47E |
| | Red Hills | 5 | Stockwater pond | T37N, R47E |
| | Red Hills | 6 | Stockwater pond | T37N, R47E |
| | Red Hills | 7 | Stockwater pond | T37N, R48E |
| | Willow Creek Seeding | 8 | Improved spring | T37N, R48E |
| | Willow Creek Seeding | 9 | Water trough | T37N, R48E |
| | Willow Creek Seeding | 10 | Water pipeline | T37N, R48E |
| | Willow Creek Seeding | 11 | Water trough | T37N, R48E |
| | Willow Creek Seeding | 12 | Water trough | T37N, R48E |
| | Willow Creek Seeding | 13 | Water trough | T37N, R48E |
| | Willow Creek Seeding | 14 | Water trough | T37N, R48E |
| | Boulder Creek | 15 | Spring | T37N, R50E |
| | Beaver Creek | 16 | Spring | T37N, R51E |
| | Sheep Creek | 17 | Water trough and pipeline | T35N, R46E;<br>T35N, R47E |
| | Santa Reina | 18 | Water trough | T37N, R49E |
| | Santa Reina | 19 | Improved spring | T38N, R49E |
| | Santa Reina | 20 | Improved spring | T38N, R49E |
| | Boulder | 21 | Water pipeline | T35N, R49E |
| Boulder Field[2] | (No water-related range improvements located in the project vicinity) | | | |
| | | | | |
| T Lazy S | Betze Post Mine Area | 1 | Stockwater pond[3] | T36N, R49E |
| | Betze Post Mine Area | 2 | Stockwater pond[3] | T36N, R49E |
| | **Betze Post Mine Area** | **3** | **Water pipeline** | **T36N, R49E** |
| | Chicken Springs | 4 | Improved spring[4] | T36N, R51E |
| | **Central Native** | **5** | **Water pipeline** | **T35N, R50E** |
| | Leeville Mine Area | 6 | Water pipeline | T35N, R50E |
| | **Leeville Mine Area** | **7** | **Improved spring[4]** | **T35N, R50E** |
| | Central Native | 8 | Improved spring[4] | T35N, R51E |
| | Central Native | 9 | Stock well[4] | T35N, R51E |
| | Central Native | 10 | Stockwater pond[4] | T35N, R51E |
| | Central Native | 11 | Improved spring[4] | T35N, R51E |
| | Central Native | 12 | Stock well[4] | T35N, R51E |
| | Lynn Creek Seeding | 13 | Stock well[4] | T35N, R51E |
| | Lynn Creek Seeding | 14 | Stock well[4] | T34N, R51E |
| | Central Native | 15 | Stock well[4] | T35N, R51E |
| | Central Native | 16 | Stockwater pond[4] | T34N, R50E |
| | **Central Native** | **17** | **Improved spring[4]** | **T34N, R50E** |
| | **Central Native** | **18** | **Improved spring[4]** | **T34N, R50E** |
| | **Central Native** | **19** | **Stockwater pond** | **T34N, R50E** |
| | Central Native | 20 | Stockwater pond | T34N, R50E |

## Table 3-7.2 (Continued)
## Water-related Range Improvements Within the 10-foot Drawdown Contour

| Grazing Allotment | Pastures | Water Source Number[1] | Water Source Type | Legal Description |
|---|---|---|---|---|
| | **Central Native** | **21** | **Improved spring[4]** | **T34N, R50E** |
| | **Central Native** | **22** | **Improved spring[4]** | **T34N, R51E** |
| | Central Native | 23 | Improved spring[4] | T34N, R51E |
| | Bob's Flat | 24 | Improved spring[4] | T33N, R50E |
| | Bob's Flat | 25 | Improved spring[4] | T32N, R50E |
| | Bob's Flat | 26 | Water pipeline | T32N, R50E |
| | Bob's Flat | 27 | Water pipeline | T32N, R50E |
| | Bob's Flat | 28 | Improved spring[4] | T32N, R50E |
| | Rodeo Creek | 29 | Water pipeline | T36N, R49E |

Sources: Master Title Plats; BLM 1993b; BLM 1996a.

[1] See Figure 3.7-2.

[2] Allotment does not have pastures.

[3] BLM 1996a.

[4] BLM 1993b.

Note: **BOLD** indicates water-related range improvements within areas potentially affected by Goldstrike Mine ground water drawdown.

Reductions in the number and distribution of water sources and reductions in permitted active grazing use would affect grazing permittees by requiring them to find additional rangeland for livestock or to reduce their herd size within the affected pasture or allotment to appropriate stocking levels as determined by the BLM. Permittees would likely try to find additional pasture to accommodate their grazing operations, otherwise the permittees would likely be subjected to economic losses if mitigation does not occur. Currently, all allotments and active permitted grazing use within the Elko District are adjudicated and the option of finding alternative rangeland for grazing is severely limited due to the limited amount of private land in the area.

Specific impacts to natural perennial water sources within the study area are described in Section 3.2.2.1. Table 3.7-2 indicates in bold type the eight water-related range improvements that could be affected. Some of the water sources in the Twenty-five and T Lazy S allotments potentially could be affected by drawdown. Impacts to water sources would not likely occur within the Boulder Field allotment, since water-related range improvements or natural perennial water sources are not present within the predicted drawdown area. Potential impacts to water sources in the Twenty-five and T Lazy S allotments are described in the following sections.

### Twenty-five Allotment

Impacts to water-related range improvements in this allotment are not anticipated as a result of ground water drawdown. A portion of Boulder Creek, located in the western portion of the Boulder Creek pasture, could potentially be affected by ground water drawdown. This segment of Boulder Creek represents approximately 30 percent of the natural perennial water sources in this pasture. The potential long-term loss of these natural perennial water sources may result in the long-term loss of permitted active grazing use or affect forage utilization. The upper portions of Boulder and Bell creeks, springs, and seeps in the central and eastern portions of the pasture would likely be unaffected by ground water drawdown and would provide alternative water sources for livestock.

### T Lazy S Allotment

Approximately 25 percent of the water-related range improvements and approximately 10 percent of the natural perennial water sources in this allotment could be affected by ground water drawdown. Eight water-related range improvements, including one stockwater pond, two water pipelines, and five improved springs, could be affected by ground water drawdown (see Table 3.7-2). One water pipeline is located in the Betze-Post Pit area and one improved spring is located in the Leeville mine area, both of which are closed to grazing. Six improvements are located in the Central Native pasture. In addition, approximately 40 percent of the natural perennial water sources located in the northwestern and southern portion of the Central Native pasture could be affected by ground water drawdown. The potential long-term loss of these water sources may result in the long-term loss of permitted active grazing use or affect forage utilization. Alternative water sources in the pasture that would likely be unaffected by drawdown include nine water-related range improvements and seeps and springs in the higher elevations of the Tuscarora Mountains.

Natural perennial water sources in the western portion of the Lower Native pasture also could be affected by ground water drawdown; these sources represent approximately 20 percent of the natural perennial water sources in this pasture. Alternative natural perennial water sources that would likely be unaffected by drawdown are present in the central and eastern portions of the pasture.

#### 3.7.2.2 Impacts to the Humboldt River

During the period of mine dewatering discharge, slightly increased water levels within the Humboldt River floodplain would likely increase the areal extent of herbaceous wetlands immediately adjacent to the river channel. Forage production and the carrying capacity of these narrow areas also would likely increase temporarily. Discharge waters reaching the Humboldt and Carson sinks would not affect grazing management since livestock grazing is not allowed within these areas. After mine dewatering discharges cease, reduced baseflows could decrease the extent of herbaceous wetlands used for grazing immediately adjacent to the river.

### 3.7.3 Monitoring and Mitigation

Water sources, including water-related range improvements and natural perennial water sources, may be lost as a result of Goldstrike Mine ground water drawdown. Barrick is responsible for long-term surface water monitoring (see Section 3.2.3) of water sources in the areas that could be affected by ground water drawdown. In pastures where grazing is allowed, the BLM would monitor forage utilization levels.

If water sources are lost, Barrick would enter into arrangements with existing area ranchers or the BLM, in the case of public land or private land where the BLM has easements or a share of the water improvement, to replace stockwater loss caused by mine dewatering. Barrick would use its existing water rights or obtain additional well permits to provide such replacement water. Mitigation measures applied to seeps and springs that may be affected could include, but are not limited to reducing livestock utilization, fencing seeps and springs with wetland/riparian vegetation, and providing other sources of livestock water.

### 3.7.4 Residual Effects

Residual effects of long-term loss of livestock water sources associated with Goldstrike Mine dewatering are not anticipated with the implementation of monitoring and mitigation measures (see Section 3.7.3).

### 3.7.5 Irreversible and Irretrievable Commitment of Resources

The loss of forage in wetlands and riparian areas affected by drawdown would be an irretrievable commitment of resources. Livestock water sources (i.e., seeps, springs) lost as a result of drawdown would be replaced (i.e., stock wells); however, the replacement of these water sources would not provide the surface water and saturated soils needed for wetland or riparian vegetation used as livestock forage. The water sources and associated forage are anticipated to recover in the long term (after 100 years).

## 3.8 Socioeconomics

This section presents a qualitative analysis of the extent to which social and economic impacts may occur from Barrick's dewatering operations.

Dewatering discharges to the Humboldt River (which are not currently planned) could provide additional water for crop irrigation. Discharges would not be likely during the summer irrigation months, so an increase in available irrigation water would be limited to additional storage in Rye Patch Reservoir with some increase in ground water storage along the river due to the higher water level during discharges. While any discharges to the river may cause additional flooding due to increased flow, the incremental increase in flow associated with Barrick's discharge is expected to be minimal. During periods of exceptionally high river flows with the potential for flooding, Barrick would cease water discharges throughout the high-water period; therefore, additional flooding due to Barrick's operations is not expected to occur.

Dewatering and the necessity for disposing of the water has led to the development of an additional 8,000 acres of irrigated hay fields with resulting hay production. Increasing the supply of hay in the region has created downward pressure on prices, and it can be concluded that the additional acreage in production has reduced costs to ranchers who buy hay for their cattle, and probably decreased income for regional competitors who produce hay for sale. As dewatering rates decline and eventually cease, the 8,000 acres of irrigated hay would be gradually removed from production, resulting in a decrease in the supply of hay within the area, and price competition would be normalized.

The cessation of dewatering operations would result in the accumulation of a ground water supplied lake in the mining pit. The resulting pit lake would lose an estimated 2,700 acre-feet of water annually to evaporation. This loss would reduce the amount of water available within the basin that might otherwise be applied to productive applications such as livestock grazing or crop irrigation.

Dewatering would likely result in some reduction of water availability for cattle grazing within the area affected by drawdown, particularly during the summer months. This drawdown could induce a slight reduction in livestock production or increased costs due to the necessity of utilizing alternative methods of providing water. This potential impact will be mitigated by Barrick's commitment to replace lost water sources.

A slight reduction in fish and wildlife resources associated with surface water and riparian areas impacted by the drawdown may occur as a result of dewatering. This impact may result in a very small reduction in hunting and fishing activities and success.

Refer to Section 5.8 for a discussion of potential cumulative socioeconomic impacts.

## 3.9 Native American Religious Concerns

Barrick's proposed dewatering and water management operations are not anticipated to affect resources of importance to Native Americans, including the Tosawihi Quarry and Rock Creek traditional cultural properties.

Refer to Section 5.9 for a discussion of potential cumulative impacts to Native American religious concerns.

## 3.10 Environmental Justice

Since publication of Executive Order (EO) 12898, Federal Action to Address Environmental Justice in Minority Populations and Low-Income Populations in the Federal Register on February 11, 1994 (59 FR 7629), Federal agencies has been developing a strategy for implementing the order. Currently, the BLM relies on the Environmental Justice Guidance Under the National Environmental Policy Act (NEPA) prepared by the Council on Environmental Quality (1997), in implementing EO 12898 in preparing NEPA documents.

Pursuant to EO 12898 on Environmental Justice, the Federal agencies shall make the achievement of environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations, low-income populations, and Indian tribes and allowing all portions of the population an opportunity to participate in the development of, compliance with, and enforcement of Federal laws, regulations, and policies affecting human health or the environment regardless of race, color, national origin, or income.

EO 12898 requires identifying and addressing disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations. The EO makes clear that its provisions apply fully to programs involving Native Americans. These requirements were addressed in preparing this SEIS by 1) ensuring broad distribution of public information on the intent to prepare the SEIS through a public scoping process begun in 1994 (see Section 6.2); 2) conducting consultation every four to six weeks with the Battle Mountain, Wells, and Elko Colonies, South Fork Band, Duck Valley Tribe, Western Shoshone Historic Preservation Society and Western Shoshone Defense Project; and, 3) conducting a field tour of the project area on June 22, 1999, in which members of the Wells, Elko, and Battle Mountain Colonies, and South Fork Band participated.

The aim of the environmental justice guidance is to prevent discriminatory placement of projects in and around minority populations in comparison to non-minority communities. The Proposed Action addressed in the SEIS is intended to link existing infrastructure that is situated on private land. Thus, the location of the Proposed Action was not selected in a manner that discriminates against minority populations. The nearest minority community is the Elko Band Colony located just outside the city limits of Elko, approximately 50 miles from the project area.

The project area is located within both the traditional territory of the Western Shoshone and the geographic boundaries established under the Ruby Valley Treaty of 1863. The Te-Moak Tribe of Western Shoshone Indians, a coalition government with headquarters in Elko, is comprised of the Elko, Battle Mountain, and Wells Colonies, and South Fork Band. The Te-Moak Tribal Council has jurisdiction over tribal lands, although the colonies retain sovereignty over local colony affairs, and each has its own separate governing council.

Government, mining, gaming, manufacturing, construction, services, and wholesale and retail trade are the principal sources of employment in both Elko and Eureka counties, with mining clearly dominating the job market in Eureka County. In 1997, of the 4,854 workers in Eureka County, 88 percent were employed in mining. Of Elko County's 20,182 workers, 7 percent were employed in the mining industry. The largest employer in Elko County was the service industries sector, employing 41 percent of the labor force (Nevada Employment Security Department 1997).

The Elko Band Council, the Te-Moak Tribe, the Te-Moak Housing Authority, the Bureau of Indian Affairs, and the U.S. Indian Health Service are the main employers of the Elko Band Colony (Gonzales 1999). Approximately 4 percent of the 250 workers are employed in mining. Currently, the rate of unemployment for the Elko Band Colony is approximately 29 percent for those between 16 and 64 years of age, willing and able to work (BIA 1999). The continuation of mining activities would have minor economic and social impacts for the Elko Band Colony within the context of current economic conditions in Elko and Eureka counties.

The Western Shoshone Historic Preservation Society and the Elko Band Council, a constituent of the Te-Moak Tribe of Western Shoshone Indians, have expressed special concern for the traditional areas of Tosawihi Quarry and Rock Creek. Dewatering activities, with the resultant reduction or loss of flow to springs, could alter the distribution or disposition of spirits associated with water. Maintaining a relationship with these spirits is central to Western Shoshone ancestral and spiritual life. Effects of the proposed dewatering activities on these Traditional Cultural Properties are examined in the technical report, *Cumulative Impact Analysis of Dewatering Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project*.

No adverse impacts that might differentially affect minority or low-income populations have been identified for the environmental factors analyzed in the Supplemental EIS. Because the local minority American Indian communities are culturally affiliated with many archaeological sites, human remains, and traditional cultural areas within the region, effects on these resources may represent differential levels of impacts to these local minority groups. Effects on such cultural resources are being considered in compliance with numerous Federal and state laws in addition to NEPA.

## 3.11 Relationship Between Short-Term Uses of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity

There would be long-term reductions in surface water flows during operations and postclosure associated with ground water drawdown from pit dewatering. Long-term impacts to riparian and wetland areas, wildlife, and other water-dependent resources would result from these reductions in surface water flows. The short-term use of resources during the project would result in beneficial impacts associated with the additional availability of water for irrigation in Boulder Valley and water uses along the Humboldt River. These impacts are expected to end upon cessation of water management operations.

# 4.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION

As described in Chapter 2.0, the Proposed Action consists of Barrick's application to amend an existing right-of-way (N-52388) by expanding the right-of-way width from 40 feet to 80 feet to accommodate installation of a second buried pipeline. A 200-foot-wide temporary construction easement would be required. The pipeline is located on private land except for 3,936 feet within Sections 32 and 4 that would be located on public land. The segment that would cross public land is the focus of this analysis. The existing pipeline located within the right-of-way was among the components analyzed in an Environmental Assessment (EA) prepared in 1990, Final Environmental Assessment for the TS Ranch Reservoir, Pipeline, and Access Road (TS Ranch Joint Venture 1990). A Finding of No Significant Impact for that proposed project was signed by the BLM on July 9, 1991. The buried pipeline proposed by Barrick would parallel the route previously analyzed in the EA.

During the operation phase, a 10-foot-wide, 2-track access road would parallel the buried pipeline. Other than ripping and revegetating the access road, abandonment would have no impact on the environment. Therefore, the discussion of environmental consequences is limited to impacts that could occur during the construction phase of the proposed pipeline.

Critical Elements of the Human Environment, as defined by BLM, are presented below along with the location in this chapter where the element is discussed. If the element does not occur within the project area or would not be affected, this is indicated below. This elimination of nonrelevant issues follows the Council on Environmental Quality guidelines as stated in 40 Code of Federal Regulations 1500.4.

- Air Quality – refer to Section 4.1.
- Areas of Critical Environmental Concern - would not be affected.
- Cultural Resources –refer to Section 4.9.
- Drinking Water/Ground Water Quality –would not be affected.
- Environmental Justice - would not be affected.
- Floodplains – would not be affected.
- Hazardous or Solid Wastes - would not be affected.
- Invasive Non-native and Noxious Plant Species – would not be affected.
- Native American Religious Concerns - refer to Section 4.9.
- Paleontological Resources - would not be affected.
- Prime or Unique Farmlands - would not be affected.
- Threatened, Endangered, Candidate, or Sensitive Species - refer to Sections 4.4 and 4.6.
- Wetlands and Riparian Zones – would not be affected.
- Wild and Scenic Rivers – would not be affected.
- Wilderness - would not be affected.

## 4.1 Air Quality

### 4.1.1 Affected Environment

The Betze Project Draft EIS (BLM 1991a) and the Meikle Mine Development EA (BLM 1993a) provide detailed information on the climatology and air quality of the area. The Goldstrike meteorological and air monitoring station measures $PM_{10}$ (particulate matter 10 microns or less) concentrations, which are representative of baseline air quality in the vicinity. Drilling, blasting, and waste rock removal, hauling, dumping, and crushing are the major sources of particulate matter. Particulate data collected from the Goldstrike meteorological station for the 1998 and 1999 monitoring periods showed no exceedences of the EPA standard for $PM_{10}$ (Barrick 2000).

In addition to particulate emissions, the existing mining and processing operations also emit other gases and "non-criteria" pollutants. Carbon monoxide (CO) and nitrogen dioxide ($NO_2$) are emitted from propane-fired kilns and boilers used in processing operations and from heavy mining equipment and other vehicles that burn diesel fuel and gasoline. Sulfur dioxide ($SO_2$), hydrogen sulfide ($H_2S$), sulfuric acid mist, and particulate sulfur are emitted during ore processing in the autoclave. $SO_2$ also is emitted by mining equipment and other vehicles that burn diesel fuel and gasoline. Barrick is not required to monitor for air quality parameters other than particulates.

Non-criteria pollutants are air contaminants that do not have standards defined within the National Ambient Air Quality Standards (NAAQS). Analysis of non-criteria pollutants concentrations was conducted as part of the Betze Project EIS (BLM 1991d). The measured concentrations of total arsenic, barium, cyanide, and selenium on the highest particulate impact days were minimal and were substantially below applicable Nevada air quality standards.

### 4.1.2 Environmental Consequences

#### 4.1.2.1 Proposed Action

Surface disturbance and the operation of heavy machinery would generate fugitive dust during construction; however, this activity would have minimal impacts on local air quality because of the small disturbance area and 2-week timeframe for construction. Soil stabilization measures following backfilling of the trench would reduce the potential for fugitive dust generation by wind blowing across disturbed area.

#### 4.1.2.2 No Action

The No Action Alternative would eliminate potential short-term impacts of the Proposed Action on air quality.

## 4.2 Topography and Soils

### 4.2.1 Affected Environment

The study area is located in the north-central portion of the Great Basin in the Basin and Range physiographic province. Boulder Valley has a low relief topography and a gentle south to southwest slope. Elevations in the area near the right-of-way range from 5,000 to 5,100 feet. Soils in the area have formed on alluvial sediments deposited by Boulder Creek and its tributaries. The soils tend to be relatively deep and well-drained.

### 4.2.2 Environmental Consequences

#### 4.2.2.1 Proposed Action

Local topography would not be affected by installation of the pipeline since the right-of-way would be graded and restored to natural contours. Based on the entire 200-foot construction right-of-way width being disturbed (which is an extremely conservative estimate), a total of 18 acres of soils could be temporarily disturbed. Appropriate construction and revegetation measures have been incorporated into the proposed plan to minimize effects to soils.

#### 4.2.2.2 No Action

The No Action Alternative would eliminate potential impacts of the Proposed Action on topography and soils.

## 4.3 Water Resources

### 4.3.1 Affected Environment

The Boulder Valley hydrographic basin is part of the Humboldt River system located in the Great Basin Physiographic Region (WESTEC 1996a). Surface flows result from snow melt, with contributions from winter and summer storm events. Surface flow within Boulder Creek and nearby ephemeral drainages typically infiltrate into alluvial aquifers and rarely reach the Humboldt River except during high run-off events or extreme precipitation.

The proposed pipeline would not cross any perennial drainages. Approximately 0.25 mile southeast of the right-of-way, Boulder Creek flows in a southwesterly direction and runs parallel to the proposed pipeline (see Figure 4-1). In 1996, a field investigation performed in the area identified one ephemeral drainage within the right-of-way as jurisdictional waters of the United States (WESTEC 1996b). Barrick applied for, and the U.S. Army Corps of Engineers has approved, a permit for the crossing of the drainage. The location of the drainage is shown in Figure 4-1.

### 4.3.2 Environmental Consequences

#### 4.3.2.1 Proposed Action

No impacts to water resources would result from construction of the pipeline, since natural topography and drainage features would be restored following construction.

#### 4.3.2.2 No Action

The No Action Alternative would have no impacts on water resources.

## 4.4 Vegetation, Including Threatened, Endangered, Candidate, or Sensitive Species

### 4.4.1 Affected Environment

The vegetation along the right-of-way consists of the big sagebrush/grassland type. Native species in the area include tall sagebrush, low sagebrush, Great Basin wildrye, buckwheat, rabbitbrush, greasewood, bluebunch wheatgrass, wild onion, phlox, and sunflower (P-III Associates, Inc. 1996). Many of the species present in the area were introduced and are non-native, such as cheatgrass, crested wheatgrass, and peppergrass.

No threatened, endangered, candidate, or sensitive plant species are known to occur in the project area. Lewis buckwheat (*Eriogonum lewisii*) is a BLM-sensitive species that has been observed in the Marys Mountain area southeast of the project area. No populations of Lewis buckwheat are known to occur in the project area.

### 4.4.2 Environmental Consequences

#### 4.4.2.1 Proposed Action

A maximum of 18 acres of the big sagebrush/grassland vegetation type would be removed by construction of the proposed pipeline; realistically, less disturbance would occur. The disturbed area would be reclaimed using an approved seed mixture (see Table 2-1). Herbaceous species (grasses, forbs) would re-establish rapidly, while shrub species (big sagebrush) would re-establish within 5 to 10 years. There is a potential for continued invasive non-native weed establishment along the pipeline right-of-way due to the existence of cheatgrass and halogeton populations in the vicinity (i.e., an existing seed source).

No impacts to threatened, endangered, candidate, or sensitive plant species are anticipated from implementation of the Proposed Action.

#### 4.4.2.2 No Action

The No Action Alternative would eliminate the effects of the Proposed Action on vegetation and would have no impacts on threatened, endangered, candidate, or sensitive species.

## 4.5 Wildlife and Aquatic Resources

Since no perennial streams would be affected by the Proposed Action, there would be no impacts to aquatic resources.

### 4.5.1 Affected Environment

The wildlife resources associated with the Proposed Action parallel those discussed for the overall project area described in Section 3.4 for Barrick's water management operations and in

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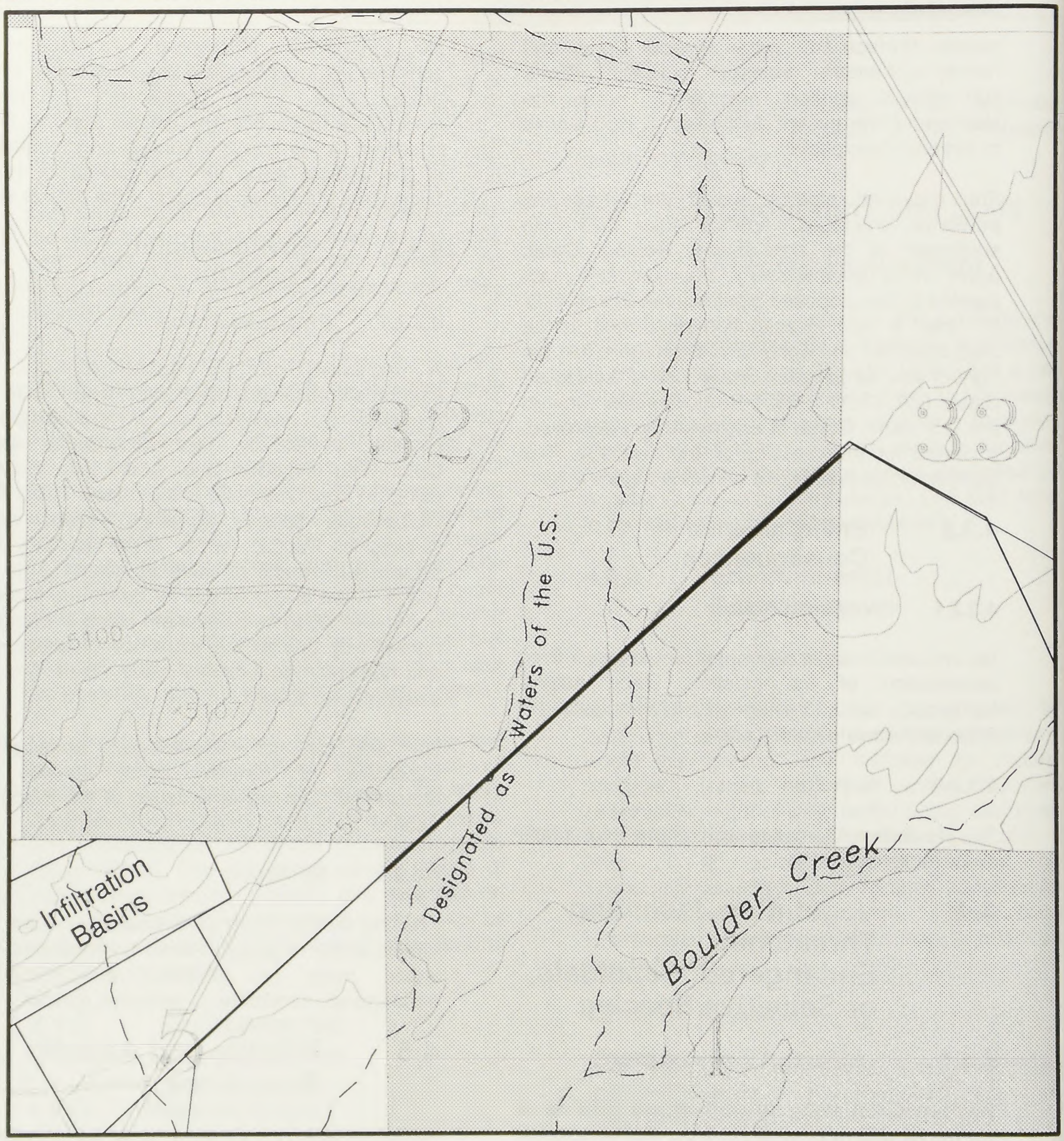

Figure 4-1

Proposed Action - Right-of-Way Location

the Betze Project EIS (BLM 1991a). However, for the Proposed Action area wildlife would be limited to those species commonly occupying the sagebrush and grassland communities.

Deer use has changed in Boulder Valley since the issuance of the Betze Project EIS. The proposed pipeline would be located between areas designated as mule deer intermediate (transitional) range and would be adjacent to designated summer range. Both of these ranges are considered important for the resident population (see Figure 3.4-1). Designated seasonal ranges for pronghorn in the vicinity of the Proposed Action include summer range to the north and east and transitional range to the west of the right-of-way alignment (see Figure 3.4-2).

Based on associated habitats, other game species that may potentially occur near the proposed right-of-way could include sage grouse, Hungarian (gray) partridge, and mourning dove. Although a number of waterfowl and shorebirds species have been documented using Boulder Valley, no suitable habitat for water birds occurs along the right-of-way.

Raptors use the sagebrush and grassland habitats for foraging. Only one raptor, the burrowing owl, has been documented nesting along the proposed right-of-way (see Section 4.6). Several other bird species, such as smaller songbirds, commonly nest in the sagebrush and grassland communities. Representative breeding species include the horned lark, mountain bluebird, sage thrasher, green-tailed towhee, and sage sparrow (BLM 1993b).

Bats would be restricted to species that commonly forage over the upland habitats that would be crossed by the right-of-way. No potential roosting habitat has been identified along the pipeline right-of-way. Reptile occurrence would be similar to that discussed for in Section 3.4, Terrestrial Wildlife. No amphibians likely occur in this area, based on the lack of moist soils, wetland areas, or perennial drainages.

## 4.5.2 Environmental Consequences

### 4.5.2.1 Proposed Action

Impacts to area wildlife would be limited to increased disturbance, short-term habitat loss, and displacement or loss of less mobile species from pipeline construction. Potential disturbance factors would include increased noise and human presence during the 2-week construction and subsequent reclamation periods. If these activities were to occur during important seasonal periods (e.g., spring or fall migration), mule deer and pronghorn would avoid the pipeline right-of-way until initial reclamation has been completed.

The anticipated displacement of individuals, interference with breeding activities, and possible mortality of the less mobile species (e.g., small mammals, ground-nesting birds) would not be expected to result in population-level effects. This assessment is based on three assumptions, including: (1) the amount of existing habitat in adjacent habitats is sufficient to support the basic functional requirements (e.g., foraging, cover) of wildlife species typically associated with the sagebrush and grassland communities in the short term, (2) the majority of these species would likely return to the right-of-way area upon the successful completion of the reclamation program, and (3) no species that would be displaced or lost are considered sensitive or rare. Threatened, endangered, candidate, or sensitive species are addressed in Section 4.6.

Although the loss of active nest sites from ground-nesting birds would not be expected to result in effects to the overall population, loss of an active nest site, incubating adults, eggs, or young would be in violation of the Migratory Bird Treaty Act. If construction activities were to occur during the breeding season (March through August), pipeline construction could impact individual nest sites, if these occurred within the areas proposed for disturbance. As discussed for potential impacts to songbirds from Barrick's dewatering and water management operations in

Section 3.4.2.2 of this SEIS, the Migratory Bird Treaty Act does not protect the loss of potential nesting habitat, but it does protect an active nest site and its occupants.

#### 4.5.2.2 No Action

The No Action Alternative would have no impacts on wildlife beyond those already occurring in the project vicinity.

## 4.6 Threatened, Endangered, Candidate, or Sensitive Wildlife Species

### 4.6.1 Affected Environment

Table 3.6-1 (see Section 3.6) summarizes the threatened, endangered, candidate, or sensitive species that may be present within the regional study area. The assumption of species' presence or absence is based on the likelihood of occurrence within the area encompassing Barrick's water management operations, relative to the sagebrush/grassland habitat type present along the proposed construction corridor.

No Federally listed, Federal candidate, or sensitive aquatic species would occur in the area of the Proposed Action, based on the lack of perennial streams. The only Federally listed terrestrial species that could potentially occur along the proposed route would be the bald eagle. However, no suitable eagle nesting or roosting habitat occurs within or adjacent to the proposed right-of-way. Consequently, potential bald eagle occurrences along the proposed route would be limited to intermittent use by migrating or foraging individuals. No site-specific information on the Preble's shrew is available (see Table 3.6-1), however, suitable upland habitats do occur in the area. Six sensitive bat species listed in Table 3.6-1 could occur sporadically in the area. However, as stated in JBR (1995a), the open valley habitats do not provide optimal roosting or foraging habitat for many of the resident and migratory bat species. Bat use associated with the area of the proposed right-of-way would be limited to foraging along the existing open-water conveyance system currently in place and within the desert shrub community. The golden eagle, Swainson's hawk, and ferruginous hawk would likely be restricted to sporadic foraging activities along the proposed right-of-way. No sage grouse activity has been documented in this area, although the habitat is suitable within the sagebrush habitat type along portions of the route.

An intensive ground survey was conducted in Boulder Valley, including the proposed right-of-way area (JBR 1996a). Based on suitable habitat recorded during these surveys, the potential occurrence of one BLM species of concern, the burrowing owl, was considered high; the burrowing owl has been documented in Boulder Valley. Three active burrow or den sites (including a colony of owls) were recorded along the northern portion of Boulder Valley in the vicinity of the proposed right-of-way during the 1996 survey (JBR 1996a). One of the burrows was located in the fill placed over the existing pipeline within the right-of-way.

Suitable habitat is not expected to be present for the other six special status species identified for the project. The osprey, American white pelican, white-faced ibis, and black tern may be attracted to the open water of the conveyance system to the south, but no habitats crossed by the proposed right-of-way would support these sensitive bird species. In addition, no suitable habitat for the northern goshawk or Nevada viceroy occurs along the right-of-way.

### 4.6.2 Environmental Consequences

#### 4.6.2.1 Proposed Action

Construction of the Proposed Action would result in the short-term loss of a maximum of 18 acres of the sagebrush/grassland habitat along the pipeline route. No impacts to the long-eared myotis, small-footed myotis, spotted bat, northern goshawk, osprey, American white pelican, white-faced ibis, black tern, or Nevada viceroy, would be anticipated from implementation of the Proposed Action. This determination is based on the lack of or limited suitable habitat along the proposed pipeline corridor for these special status species.

Although the potential occurrence of the Preble's shrew in the proposed project area would be considered low, potential impacts could result in the loss of individuals as result of crushing from construction activities, if this small mammal species is present. Impacts to this species also would result in the incremental short-term loss of potentially suitable breeding and foraging habitat. A number of resident and migratory bat species (i.e., long-legged myotis, fringed myotis, and pale/Pacific Townsend's big eared bat) and raptor species (i.e., bald eagle, golden eagle, Swainson's hawk, and ferruginous hawk) may sporadically occur in the habitats crossed by the proposed Project ROW. Consequently, the proposed Project could result in the incremental, short-term loss of potentially suitable foraging habitat along the proposed route. Potential impacts to sage grouse would be limited to the incremental, short-term loss of potentially suitable foraging, habitat.

Burrowing owls may be both directly and indirectly impacted by the construction of the Proposed Action. The maximum of 18 acres of the sagebrush/grassland habitat temporarily lost from pipeline construction would result in a short-term reduction in potential nesting and foraging habitat for this species. Individual owls also may be directly affected by pipeline construction, if equipment were to crush an active den or nest site along the proposed right-of-way. This event could result in loss of eggs, nestlings, and adults. The general breeding season for burrowing owls may extend from March through August (Call 1978; Terres 1991), depending on nest phenology, with the young often remaining with the burrow until migration (August to September). If construction were to occur during these periods, construction activity could directly impact adults and young (both nestlings or fledglings), if the burrow were active. As discussed for ground-nesting songbirds in Section 4.5.2.1, direct impacts to nesting burrowing owls would be in violation of the Migratory Bird Treaty Act.

#### 4.6.2.2 No Action

The No Action Alternative would have no impact on threatened, endangered, candidate, or sensitive species.

## 4.7 Grazing Management

### 4.7.1 Affected Environment

The proposed pipeline right-of-way is located on public land within the boundaries of the T Lazy S Allotment. This allotment is described in Section 3.7, Grazing Management.

### 4.7.2 Environmental Consequences

#### 4.7.2.1 Proposed Action

Construction of the buried pipeline would result in the temporary loss of forage within the proposed disturbance area (up to 18 acres). This area would be revegetated after construction. The loss of forage within this area would be minimal relative to the total area available for livestock grazing.

#### 4.7.2.2 No Action

The No Action Alternative would eliminate the potential impacts of the Proposed Action on grazing management.

## 4.8 Access and Land Use

### 4.8.1 Affected Environment

The primary land uses in the vicinity of the project in terms of acreage and economic impact are ranching and mining activities, respectively. The proposed right-of-way is located on public land (Sections 32 and 4) administered by the BLM. The surrounding sections are private lands owned by the Elko Land and Livestock Company. Dunphy Road and other unpaved intersecting access roads provide access to the area for mine employees and ranchers.

### 4.8.2 Environmental Consequences

#### 4.8.2.1 Proposed Action

The proposed pipeline project would increase the quantity of water that can be delivered for irrigation by approximately 8,000 gpm during peak irrigation periods. The in-place abandonment of the buried pipeline would encumber these lands and result in potential future conflicts with other land uses. There would be no impacts to area access.

#### 4.8.2.2 No Action

Under the No Action Alternative, the ability to increase the delivery of water to irrigation by approximately 8,000 gpm during peak irrigation periods would not be realized. The No Action Alternative would eliminate the potential impacts on land use in the project area and have no effect on access.

## 4.9 Cultural Resources

### 4.9.1 Affected Environment

#### 4.9.1.1 Cultural Resources Identified in the Project Area

Several cultural surveys have been conducted in the vicinity of the proposed right-of-way by P-III Associates, Inc. (P-III). These include surveys near the Ranch Reservoir by Tipps and Popek (P-III 1990), inventories of five parcels in the upper Boulder Valley by Tipps (P-III 1991), and inventories on 520 acres in Boulder Valley (P-III 1996). These surveys are on file at the BLM office in Elko, Nevada; only summaries are provided here to protect the confidentiality of the site locations.

In July and November 1989, Tipps and Popek (P-III 1990) conducted cultural resource investigations near the TS Ranch Reservoir. In April and May 1991, Tipps (P-III 1991) conducted Class III surveys of 1,717 acres of private land in the northern portion of Boulder Valley. Several lithic scatters were identified during these surveys in and near the proposed pipeline right-of-way. These sites were recommended ineligible to the NRHP by the field archeologists; BLM and SHPO agreed with this recommendation. P-III (1996) conducted a survey in the vicinity of the project area in May 1996, and no additional sites were located during this survey.

Class III cultural resources inventories were completed along the entire pipeline route. No archaeological finds were encountered during installation of the pipeline on private land leading to and from proposed right-of-way on the public land parcel.

#### 4.9.1.2 Native American Concerns

Recent legislation and regulations provide for Federal agencies to consult with Native Americans before certain types of land or resource management decisions are implemented. These acts and regulations, which provide a measure of protection to traditional Native American religious and other cultural beliefs and practices, include: (1) the American Indian Religious Freedom Act; (2) the Religious Freedom Restoration Act; (3) the Archaeological Resources Protection Act; (4) the National Historic Preservation Act, as amended to provide a role for Indian Tribal groups in Section 106 consultation provisions; (5) the Native American Graves Protection and Repatriation Act; and (6) the Nevada Indian Burial Protection legislation.

Notification letters and requests for comments were sent to the Te-Moak Tribe, the South Fork Band, the Wells Band, the Battle Mountain Band, and the Elko Band; the Duck Valley Tribe; the Fort Hall Tribe; the Western Shoshone Defense Fund; and the Western Shoshone Historic Preservation Society.

The Native American consultation process relative to the potential impacts of dewatering and water management operations is summarized in Section 6.4.

### 4.9.2 Environmental Consequences

#### 4.9.2.1 Proposed Action

No sites within the proposed pipeline project area have been deemed to be significant or eligible for inclusion on the National Register of Historic Places (NRHP), or have Federal and/or state protection under other statutes. Section 106 consultation with the Nevada State Historic Preservation Officer regarding the project's effect on cultural resources has been completed. No sites known to be of religious or cultural significance to Native Americans would be impacted by the proposed pipeline.

Any previously unidentified cultural resources located during construction should be examined by professional archaeologists prior to removal. If the previously unidentified resources were judged eligible for the NRHP or protected under state and Federal statues, impacts should be mitigated through an appropriate data recovery program agreed upon by the BLM, the State Historic Preservation Officer and the Advisory Council on Historic Preservation.

#### 4.9.2.2 No Action

Under the No Action Alternative, impacts to cultural resources or sites known to be of religious or cultural significance to Native Americans from construction of the pipeline would not occur.

## 4.10 Visual Resources

### 4.10.1 Affected Environment

The proposed buried pipeline route is situated on lands designated as Visual Resource Management (VRM) Class IV by the BLM. The VRM system ratings range from Class I to Class IV, with Class I areas being the most scenic and protected visual resources, and Class IV, the least valuable resource and needing the least protection. Class IV VRM objectives provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements (BLM 1986a).

The topography of project area is fairly uniform. Grasses and sagebrush comprise the prevalent vegetation, and there is little contrast in form, line, color, and texture along the right-of-way relative to the surrounding area.

### 4.10.2 Environmental Consequences

#### 4.10.2.1 Proposed Action

The 2-week construction disturbance, followed by the period until vegetation becomes re-established (likely several years), would result in a temporary contrast in color and texture relative to the surrounding area. The rangeland that would be crossed by the right-of-way would accommodate the pipeline project because reclamation would restore the original landform, and revegetation would approximate original colors and textures. The project would be compatible with the VRM Class IV designation.

#### 4.10.2.2 No Action

Under the No Action Alternative, no effects to visual resources associated with the buried pipeline would occur.

## 4.11 Mitigation Measures

As summarized in Section 1.6, applicable monitoring and mitigation measures have been developed for the project, based on the existing water management operations. The following monitoring and mitigation measures are proposed for implementation of the Proposed Action in addition to the environmental protection measures presented in Section 1.6.

Ground-Nesting Birds

To minimize potential impacts to ground-nesting birds, either pipeline construction would occur outside of the primary breeding season (construction window of September through February), or a breeding bird survey would be conducted to identify active nest sites prior to the initiation of construction. In the event that construction activities were proposed for the breeding period (March through August), Barrick would coordinate with the BLM on the survey methodology (e.g., distance from centerline) and contract with a qualified biologist to conduct a clearance survey along the project right-of-way and in other native habitats that may be disturbed by pipeline construction (e.g., laydown area). If an active nest site is documented in or near these areas to be disturbed, Barrick would coordinate with the BLM to determine whether additional protection measures are warranted (e.g., protective buffer, construction constraint, etc.). These decisions would be based on the species potentially affected, the location of the nest site relative to the construction activities, and breeding phenology. This measure should prevent violation of the Migratory Bird Treaty Act.

Breeding Burrowing Owls

Similarly to other ground-nesting birds (see above), if construction of the proposed water pipeline were to occur during the breeding season for the burrowing owl (March through August), a clearance survey for breeding or nesting burrowing owls would be conducted within 0.25 mile of the pipeline right-of-way to determine if an occupied breeding territory or an active nest site occurs in or adjacent to the right-of-way alignment or other areas proposed for disturbance (e.g., laydown area). In the event that breeding adults or young are documented during these clearance surveys, Barrick would coordinate with the BLM to determine if additional protection measures were warranted. These measures could include establishing buffer areas surrounding a nest site; implementing a construction constraint period; restricting human access in close proximity to a nest site; and/or constructing artificial burrows, if warranted. The extent of these measures would depend on a number of factors, such as the location of the nest relative to the right-of-way, potential shielding from vegetation, breeding phenology, and the types of activities planned for the area within 0.25 mile of a nest site. This measure should protect breeding burrowing owls and adhere the regulations of the Migratory Bird Treaty Act.

## 4.12 Residual Effects

The in-place abandonment of the proposed water pipeline would encumber these lands, possibly resulting in future conflicts with other land uses. No other residual effects to environmental resources would result from implementation of the Proposed Action.

## 4.13 Irreversible and Irretrievable Commitment of Resources

Irreversible impacts apply to non-renewable resources. For example, if cultural resource sites were disturbed by construction of the Proposed Action, it would be considered an irreversible commitment of resources. Irretrievable impacts apply to the loss of production, harvest, or use of renewable natural resources. Minor irretrievable losses such as soil disturbance, vegetation loss, and a loss of wildlife habitat would occur from construction of the proposed pipeline until vegetation is re-established.

## 4.14 Relationship Between Short-Term Uses of the Human Environment and the Maintenance and Enhancement of Long-Term Productivity

Most of the impacts associated with the Proposed Action would be short-term and would cease to be adverse impacts following revegetation of the disturbed right-of-way. No substantial decrease in the productivity of the project area is anticipated.

# 5.0 CUMULATIVE IMPACTS

The Elko Field Office of the BLM is currently preparing three EISs for mining operations within their jurisdiction. These documents are this Betze Project Supplemental EIS, Newmont Gold Company's SOAPA EIS, and Newmont Gold Company's Leeville Project EIS. During the preparation of these three EISs, the BLM determined the potential exists for cumulative environmental impacts associated with the ground water pumping and water management operations of these mines. To facilitate preparation of these EISs, the BLM directed the three third-party EIS contractors to cooperatively prepare a CIA report to address potential cumulative dewatering and discharge impacts for all three mine projects. This report, *Cumulative Impact Analysis of Dewatering and Water Management Operations for the Betze Project, South Operations Area Project, and Leeville Project* (BLM 2000b), is available for review at the BLM Elko Field Office.

This section summarizes the potential cumulative impacts to environmental resources associated with the Goldstrike, Gold Quarry, and Leeville mines in the case of ground water drawdown, and the Goldstrike, Gold Quarry, Leeville, and Lone Tree mines in the case of dewatering discharge to the Humboldt River, as described in the CIA report (BLM 2000b). In addition, the BLM considered the potential effects of other past, present, and reasonably foreseeable future actions that may potentially affect ground water and surface water resources within the area of potential effect, including the Humboldt River.

Resources addressed in this cumulative analysis include geology, ground and surface water resources, riparian areas and wetlands, terrestrial wildlife, aquatic habitat and fisheries, special status species, livestock grazing, socioeconomics, and Native American religious concerns.

The cumulative impacts identified in this SEIS and in the CIA report (BLM 2000b) are associated with Barrick's dewatering and water management operations. No cumulative impacts have been identified relative to the Proposed Action (i.e., buried pipeline) and the No Action Alternative analyzed in this SEIS.

## 5.1 Geology

### 5.1.1 Mine Dewatering and Localized Water Management Activities

The primary issue identified for this assessment of cumulative geologic impacts is the potential for development of sinkholes or other karst-type collapse features that could result from mine-induced drawdown and water management activities. Three sinkholes have been documented to-date in the area since dewatering operations were initiated at the Goldstrike and Gold Quarry mines: (1) a sinkhole approximately 3.5 miles northwest of the center of the Betze-Post Pit, (2) a sinkhole approximately 2.8 miles west of the center of the Betze-Post Pit located near spring 6, and (3) a sinkhole along Maggie Creek in an area referred to as the Maggie Creek Narrows.

The criteria described previously in Section 3.1.2.1, were combined with available information on the geology in the region (including location of carbonate outcrop areas and materials above the carbonate rocks), and prediction of ground water drawdown to develop a map (Figure 5-1) illustrating areas that could potentially be susceptible to sinkhole development. The areas where carbonate rocks are located at or near the surface, and assumptions of overburden materials (alluvium or insoluble bedrock) were based on available regional geologic information (Maurer et al. 1996; Newmont 1998). The general depth to the carbonate rocks was based on available well completion logs for monitoring wells completed by Barrick and Newmont.

The results of this evaluation delineate several areas that could potentially be susceptible to sinkhole development. As illustrated in Figure 5-1, areas potentially susceptible to sinkhole development include the large area underlain by carbonate rock located between the Betze-Post Pit and Gold Quarry Pit, the area northwest of the Betze-Post Pit, the Maggie Creek area located north of the Gold Quarry Pit,

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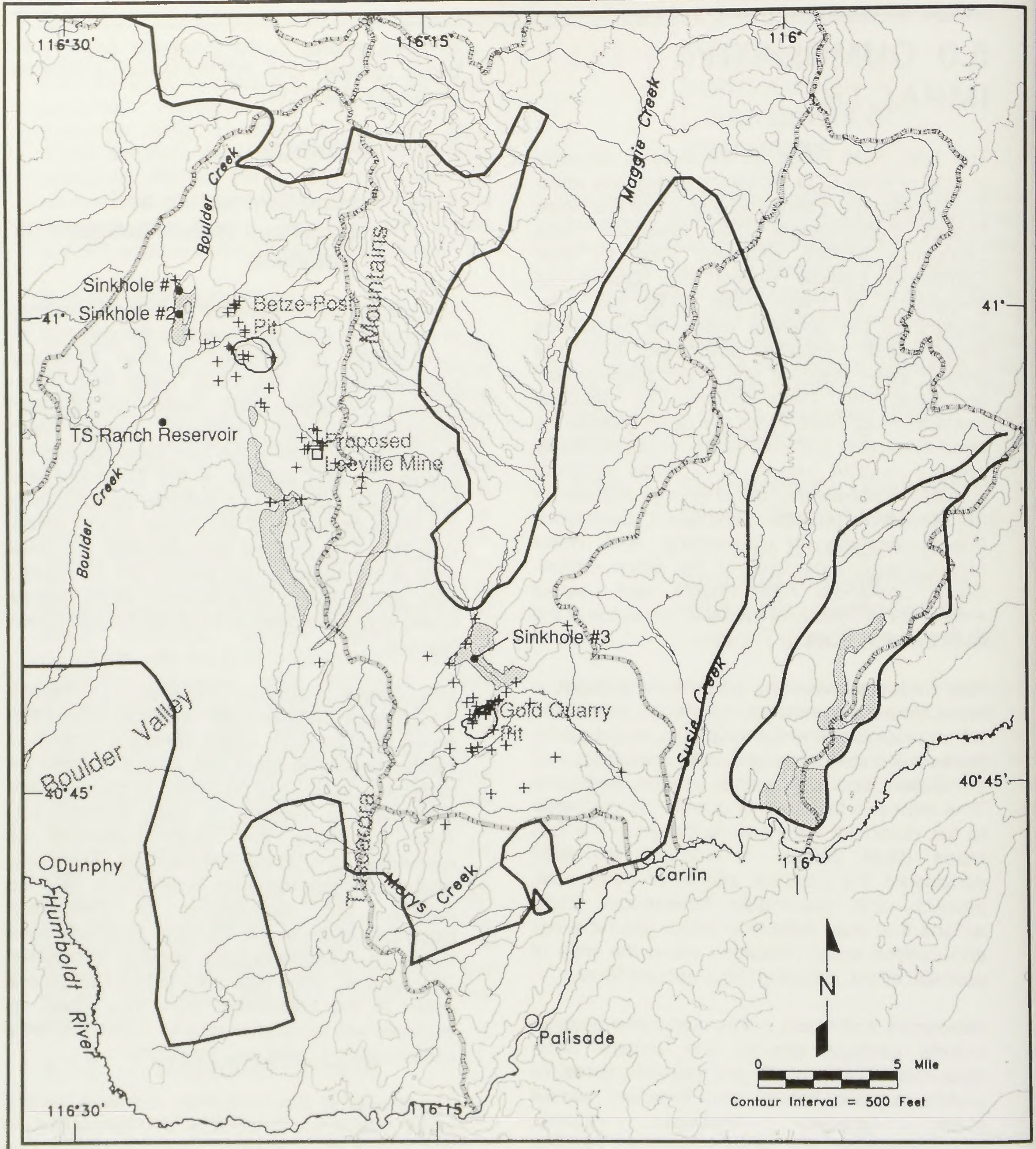

Legend

Ground Water Basin Boundary

Stream

Cumulative Drawdown Area (≥10 Feet of Drawdown)

+ Well Used to Define Depth to Limestone

▨ Areas that Could Potentially be Susceptible to Sinkhole Development

☐ Areas Unlikely to be Impacted by Sinkhole Development

Figure 5-1

Areas Potentially Susceptible to Sinkhole Development and an area located west of the Gold Quarry Pit. These areas contain few buildings, major roads, or other infrastructure, critical mine-related facilities such as waste rock storage facilities, heap leach pads, and mill and tailings facilities are not located within these areas. A segment of a power line associated with the Carlin Mine occurs within an area that could be susceptible to karst development. Other non-mine-related features of note located within these areas include a 1-mile segment of Boulder Creek, a 1-mile segment of Sheep Creek, a 2.5-mile segment of Maggie Creek, several springs and intermittent streams, a corral, and several unpaved dirt roads.

### 5.1.2 Humboldt River

No cumulative geologic impacts are anticipated to the Humboldt River as a result of increased or decreased river flows or dewatering.

### 5.1.3 Proposed Action and No Action Alternative

No cumulative geologic impacts are anticipated from the Proposed Action or No Action Alternative.

## 5.2 Water Resources and Geochemistry

The following discussion summarizes the cumulative impacts to water resources presented in the CIA report (BLM 2000b). Primary issues addressed in this analysis of cumulative impacts to water resources include the following:

- Reduction in surface and ground water quantity for current users and water-dependent natural resources due to pit dewatering and water management activities

- Impacts to flow in the Humboldt River from direct mine discharge, mine-induced drawdown and mounding, and projected irrigation withdrawals and return

- Impacts to surface water quality from mine water management, including impacts to Humboldt River water quality

- Potential increases in flooding, erosion, and sedimentation associated with water management activities

- Potential changes in the water balance of the hydrologic study area resulting from the existing and proposed mining activities

For the evaluation of cumulative impacts to water resources, the affected environment consists of two study areas: (1) a hydrologic study area for mine dewatering (and localized water management activities), and (2) a Humboldt River study area for evaluating potential effects associated with discharge of excess mine water to the river system.

The cumulative hydrologic study area for mine dewatering encompasses approximately 2,060 square miles and includes six designated ground water basins established by the Nevada Division of Water Resources (Figure 3.2-1). These ground water basins, state identification numbers, and land surface areas are listed in Table 3.2-1. All of these ground water basins drain southward to the Humboldt River. The affected environment for the hydrologic study area for mine dewatering is summarized in Section 3.2.1.2.

The cumulative Humboldt River study area consists of the Humboldt River and its floodplain extending from the USGS gage at Carlin to the Humboldt Sink downstream of Lovelock (Figure 1-6). Quantitative assessments have been conducted for the river from Carlin to the USGS gage at Comus, approximately 9 miles east of Golconda. The Comus gage is approximately 1 mile downstream of the Lone Tree Mine discharge point and reflects the cumulative discharge from the Goldstrike, Gold Quarry, Leeville, and Lone Tree mines. Semi-quantitative or qualitative assessments have been conducted from Comus to the Humboldt Sink. The affected environment for the Humboldt River study area is summarized in Section 3.2.1.3.

The cumulative impact analysis for water resources and geochemistry is subdivided into two primary sections. Section 5.2.1 describes potential cumulative impacts associated with ground water drawdown and mounding from past, present, and future dewatering activities (and other local water management activities) at the

Goldstrike Mine, Gold Quarry Mine, and proposed Leeville Mine located along the Carlin Trend. Section 5.2.2 describes potential cumulative impacts associated with mine discharges to the Humboldt River. The Humboldt River evaluation considers potential effects between the USGS gage near Carlin and the Humboldt Sink downstream. The analysis considers effects of historic and future discharges from the Goldstrike Mine, Gold Quarry Mine, proposed Leeville Mine, and Lone Tree Mine on flow, water quality, and channel stability.

### 5.2.1 Mine Dewatering and Localized Water Management Activities

Table 1-4 summarizes both the historic and projected future dewatering activities for the Goldstrike Mine, Gold Quarry Mine, and proposed Leeville Mine. The historic activities extend from the initiation of ground water pumping for the mines through the end of 1998. The projected future dewatering and water management activities extend from 1999 through the currently projected end date for ground water pumping and water management activities for each operation.

#### 5.2.1.1 Impacts to Ground Water Levels

Impacts to-Date (1991-1998)

As of the end of 1998, 1,527 feet of drawdown had occurred to-date in the vicinity of the Goldstrike Mine, and 658 feet of drawdown had occurred in the vicinity of the Gold Quarry Mine as a result of mine dewatering. In the vicinity of the proposed Leeville Mine, 360 feet of drawdown had occurred from existing dewatering operations at other mines. As shown in Figure 5-2, mine dewatering has resulted in the development of cones of depression in the ground water surface in the vicinity of the Goldstrike and Gold Quarry mines; both cones of depression exhibit a northwest-southeast elongation. Where the cones of depressions from the two projects overlap, there are cumulative drawdown effects caused by a combination of incremental drawdown from each project. To-date, the cones of depression from the two mines apparently have merged in the region between the two mines located beneath the Tuscarora Mountains southeast of the Carlin Mine.

Infiltration of excess mine water from the dewatering operations has resulted in an increase in water levels, or mounding, in the upper Boulder Valley and lower Maggie Creek areas. As of the end of 1998, water levels in the Boulder Valley region had risen approximately 70 feet in the rhyolite in the Sheep Creek Range and 50 feet in the alluvium in upper Boulder Valley. Seepage from Maggie Creek Reservoir and through infiltration along portions of lower Maggie Creek has resulted in an increase in water levels up to 45 feet.

As discussed in Section 3.2.2, several springs located within the current drawdown area resulting from dewatering at the Goldstrike Mine have dried up or shown a reduction in flow (see Table 3.2-22); some of these effects may be related to mine dewatering. The flow and vegetation in Brush Creek, a tributary to Rodeo Creek, have changed substantially since 1993, indicating that this drainage has been impacted by mine dewatering. No other stream impacts have been identified on the western side of the Tuscarora Mountains. In addition, no effects on monitored spring flows have been identified in the vicinity of the Gold Quarry Mine.

Predicted Future Impacts (Post-1998)

Both Barrick and Newmont have developed numerical ground water models that encompass the regional hydrologic study area. Each model was used to simulate the combined or cumulative hydrologic effects resulting from dewatering and water management activities at all three mines (Goldstrike, Gold Quarry, and Leeville). An overview of the model set-up and results of the cumulative simulations for different time periods are provided in Appendix D of the CIA report (BLM 2000b).

Both models predict that the extent and magnitude of the cone of drawdown would vary over time and persist for an extended period postmining (see Appendix D of the CIA report [BLM 2000b]). As a result of conceptual differences in hydrogeologic conditions, including hydraulic parameters, each model produces

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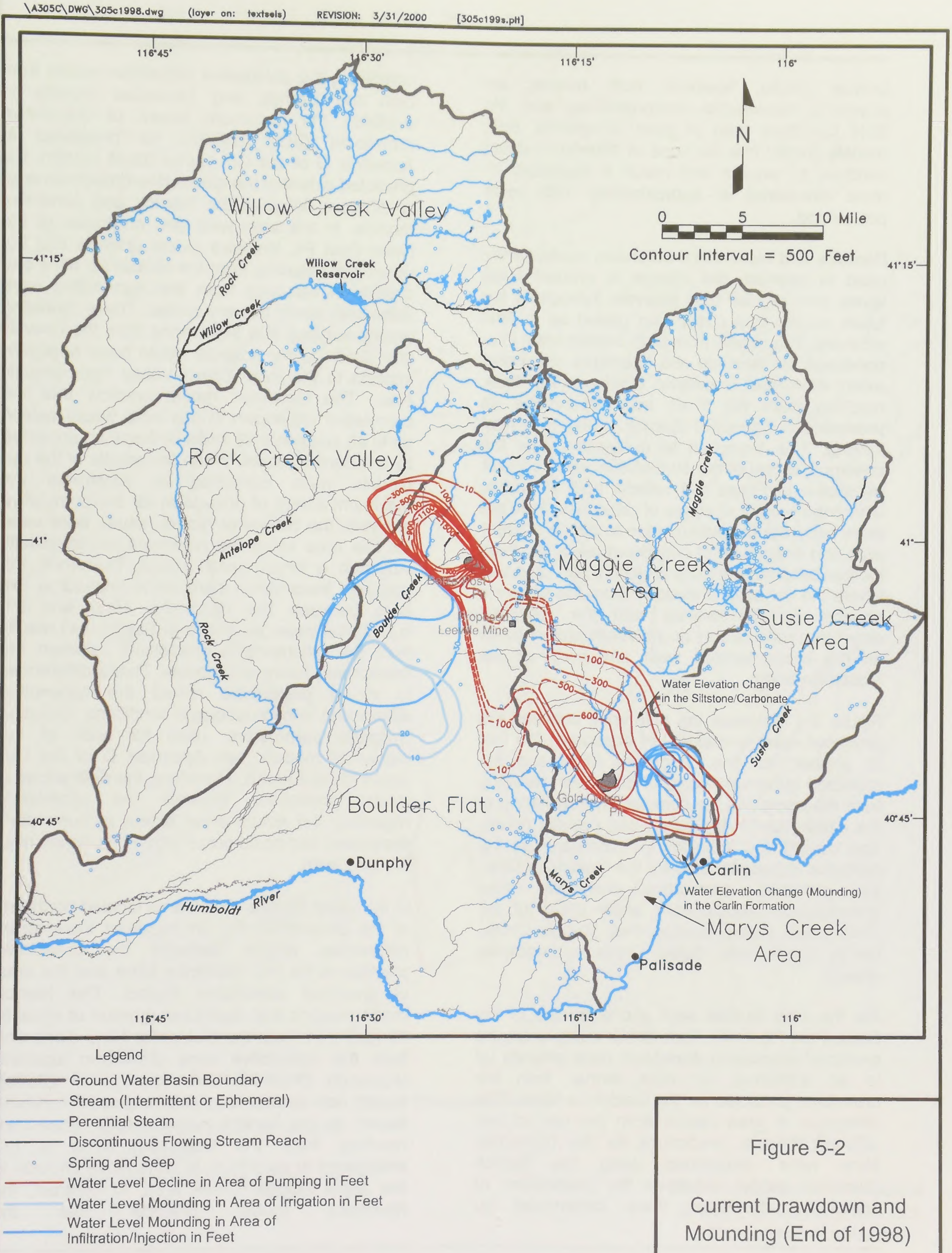

Figure 5-2

Current Drawdown and Mounding (End of 1998) unique results; however, both models are physically reasonable interpretations, and the BLM considers both of them acceptable. Both models predict that the cone of drawdown would continue to expand and reach a maximum (in most directions) at approximately 100 years postmining.

Barrick's and Newmont's calibrated models were used to estimate the change in ground water levels over regular time intervals throughout the future mining and postmining period up to final recovery. The results from both models were then combined to illustrate the predicted maximum extent of 10-foot drawdown irrespective of time, resulting from the three mine operations as presented in Figure 5-3 (Barrick 1998c; Newmont 1999a). It is important to understand that the maximum extent of the 10-foot drawdown contour as shown in Figure 5-3 reflects both (1) areas where the individual cones of drawdown from the three separate projects overlap to cause a larger area and magnitude of drawdown (such as areas located between the mine projects); and (2) areas where the cones of drawdown from the separate projects do not overlap and the predicted drawdown reflects only an individual project (such as the areas located west and north of the Goldstrike Mine).

Figure 5-4 illustrates the difference between the predicted maximum extent of drawdown (10 feet or greater) for the Goldstrike Mine and the predicted maximum extent of drawdown resulting from the combined (or cumulative) dewatering at the Goldstrike, Gold Quarry, and Leeville mines. This comparison indicates that compared to the predicted drawdown area for the Goldstrike Mine, the predicted cumulative drawdown area encompasses substantially larger areas of the Rock Creek Valley, Boulder Flat, Maggie Creek, Marys Creek, and Susie Creek hydrographic areas.

For the area located west and northwest of the Betze-Post Pit, in the Rock Creek Valley area, the predicted cumulative drawdown cone extends up to an additional 12 miles farther than the drawdown predicted for the Goldstrike Mine. This difference in area results from the use of two different models; predictions for the Goldstrike Mine were determined using the Barrick numerical model, whereas the predictions of cumulative drawdown were determined by combining the cumulative simulation results from both the Barrick and Newmont models to establish the maximum extent of cumulative drawdown (BLM 2000b). As presented in Appendix D of the CIA report (BLM 2000b), the predicted extent of the cumulative drawdown area is different between the Barrick and Newmont models. In the area west and northwest of the Betze-Post Pit, Barrick's model predicts that the drawdown resulting from the Goldstrike Mine and drawdown resulting from the cumulative mine drawdown would be very similar. These modeling results suggest that dewatering from the Leeville and Gold Quarry projects would have negligible impacts to the Rock Creek Valley Hydrographic Area. The Newmont model predicts that the cumulative drawdown in this area would extend up to an additional 12 miles farther than predicted by the Barrick model. When the results of the two models were combined to determine the maximum extent of drawdown for the cumulative analysis, the Newmont model results were used for this area since the Newmont model results indicated a larger areal extent. Therefore, the apparent incremental increase in impacts in this area between the Goldstrike Mine and the cumulative case (as shown in Figure 5-4) results from the difference in predictions between the Barrick and Newmont models. These differences in model predictions reflect the conceptual differences in hydrogeologic conditions, including hydraulic parameters, used for each of the numerical models (see Appendix D of the CIA report [BLM 2000b]). Therefore, the differences in model predictions illustrate the uncertainty regarding the actual areal extent of cumulative drawdown that could occur within this region over the long term.

In the upper Maggie Creek area located northeast of the Betze-Post Pit, an apparent incremental differences occurs between the drawdown predictions for the Goldstrike Mine and the area of predicted cumulative impact. The Barrick model predicts that drawdown (greater or equal to 10 feet) from both the Goldstrike Mine alone and from the cumulative mine drawdown scenario (Appendix D of the CIA report [BLM 2000b]) would not extend into this region. Therefore, based on the Barrick model results, drawdown resulting from the Goldstrike Mine is not anticipated to contribute to cumulative impacts to the upper Maggie Creek area. In contrast, the Newmont model predicts that the

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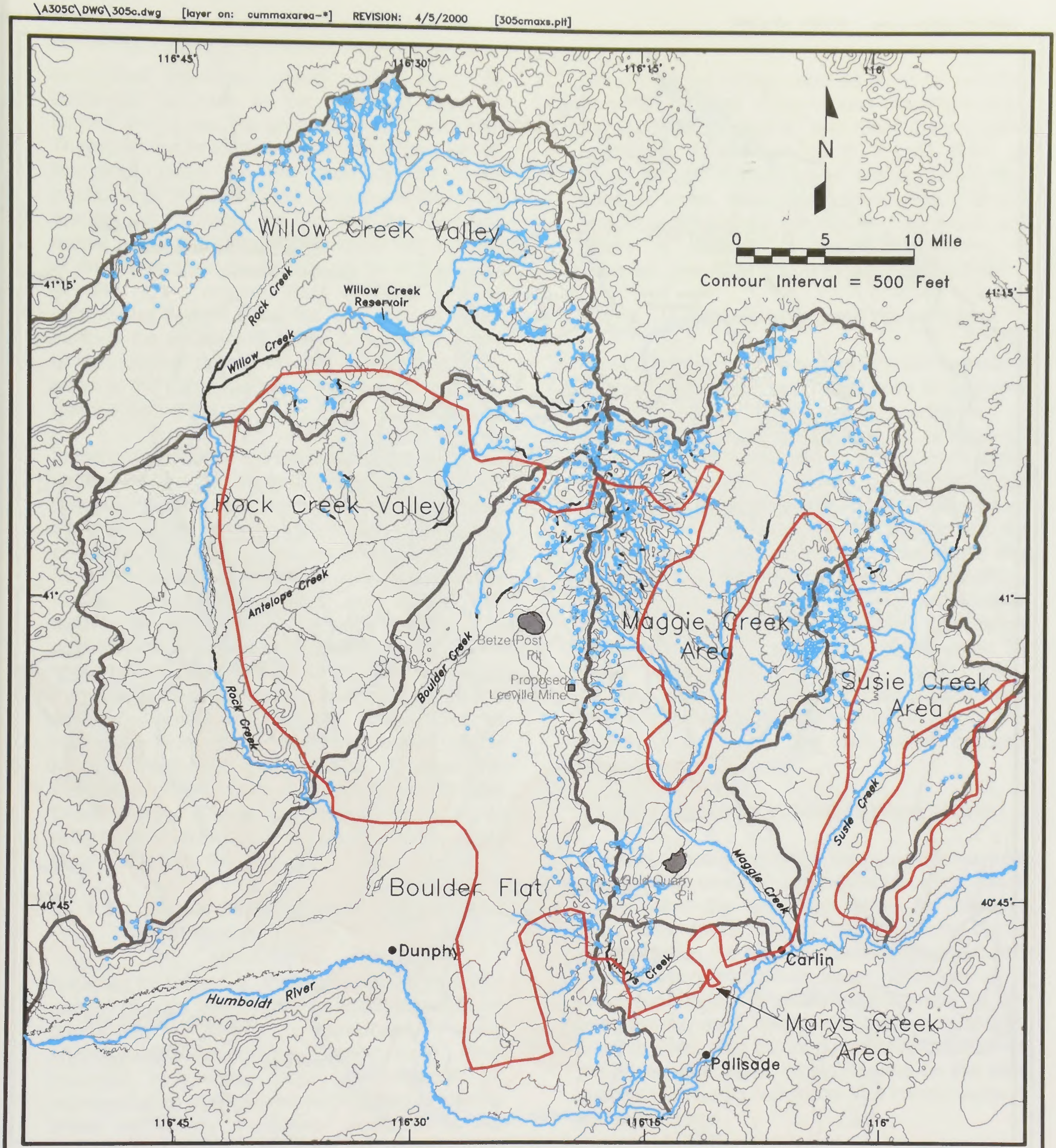

Legend

- Ground Water Basin Boundary
- Maximum Extent of the Cumulative 10-foot Drawdown Contour
- Stream (Intermittent or Ephemeral)
- Perennial Steam
- Discontinuous Flowing Stream Reach
- Spring and Seeps

Figure 5-3

Predicted Maximum Extent of the Cumulative 10-Foot Drawdown Contour

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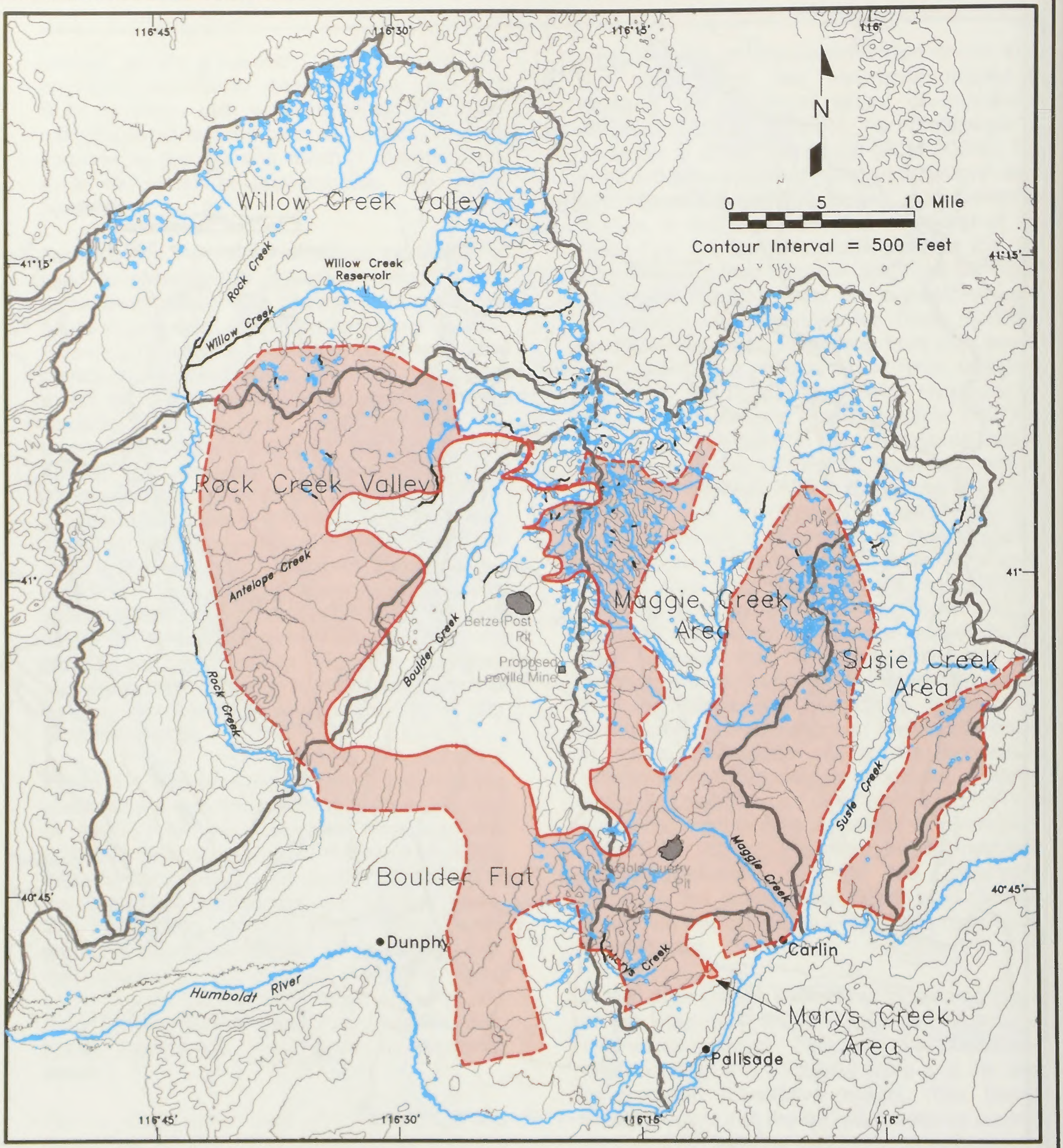

[1] See text in Section 3.2.2.1 for explanation

[2] See BLM 2000b for explanation

Figure 5-4

Comparison of the Predicted Goldstrike Mine Drawdown Area and the Cumulative Drawdown Area cumulative drawdown would extend up to an additional 10 miles to the northeast than the Barrick model into the upper Maggie Creek area. Therefore, the predicted cumulative drawdown for this area, based on the maximum drawdown predicted by the combined Barrick and Newmont models, also reflects the fact that the Newmont model predicts a substantially larger areal extent of drawdown than the Barrick model (Appendix D of the CIA report [BLM 2000b]). These contrasting results from the two models again indicate the uncertainty of the actual areal extent of cumulative drawdown that could potentially occur in the upper Maggie Creek area in the post-dewatering period.

In the area between the Goldstrike Mine and Gold Quarry Mine, the increase in drawdown area predicted for the Goldstrike Mine compared with the cumulative scenario reflects the overlapping cones of depression (or incremental contribution) from the Goldstrike, Gold Quarry, and Leeville mines. The Leeville Project, and to a lesser extent the Gold Quarry Project, would likely contribute to the cumulative drawdown in portions of the Boulder Flat Hydrographic Area. Drawdown from the Goldstrike Mine is predicted to have a relatively small incremental contribution to drawdown along the southwestern portion of the Maggie Creek Hydrographic Area. However, the increased drawdown area in the lower Maggie Creek, Marys Creek, and Susie Creek areas reflects the drawdown cones from the Gold Quarry and Leeville mines.

#### 5.2.1.2 Impacts to Perennial Springs and Streams

As listed in Table 5-1, there are 537 springs and seeps located within the predicted combined cumulative 10-foot drawdown area. Hydrogeologic conditions, spring and seep surveys, elevations, and geochemistry for representative springs were considered to identify areas within the maximum predicted 10-foot contour that could potentially be impacted by mine dewatering (BLM 2000b). Based on the cumulative analysis, 182 springs and seeps are located in areas where perennial surface waters could potentially be impacted by drawdown (Figure 5-5). These potential impacts are discussed in detail by area in the CIA report (BLM 2000b).

Flows in some stream reaches could be reduced as a result of the mine-induced drawdown from the Goldstrike, Leeville, and Gold Quarry mine operations. Drawdown could impact flows in lower Maggie Creek, lower Marys Creek and adjacent areas, lower Susie Creek, Rock Creek, and Boulder Creek; the actual magnitude and extent of impacts to perennial streams is uncertain (see BLM 2000b for additional details).

#### 5.2.1.3 Impacts to Ground Water Rights

Ground water modeling results indicate that water levels at 115 ground water right point of diversion locations (with current *permit*, *certificate*, or *vested* status) could be lowered by at least 10 feet during the mine life or in the postmining period as a result of Barrick and/or Newmont ground water pumping (Table 5-2). The point of diversion locations listed for 34 applications for ground water rights also are located within the cumulative 10-foot drawdown contour. In addition, there are five known wells (without water rights status) located within the identified cumulative drawdown area. Lowering the water levels in these wells would potentially reduce yield, increase pumping cost, or if the water level were lowered below the pump setting or below the bottom of the wells, the well would become unusable.

#### 5.2.1.4 Impacts to Surface Water Rights

A potential reduction in the baseflow of perennial springs and streams could affect surface water rights within the drawdown area. As listed in Table 5-3, there are 45 surface water rights located within the potential cumulative drawdown area. Thirty-two of these water rights are used either for irrigation or stock watering, and 13 are used for domestic, mining and milling, municipal, or other uses. The actual potential for impacts to individual water rights would depend on the site-specific hydrologic conditions that control surface water discharge.

#### 5.2.1.5 Impacts to the Regional Ground Water Balance

As presented in Tables 1-4 and 1-5, the combined pumping from the Goldstrike, Gold Quarry, and Leeville mines would result in an estimated total pumped volume of approximately

## Table 5-1
## Summary of Springs Within the Predicted Cumulative Drawdown Area

| Ground Water Basin | Total Number of Known Springs and Seeps Within Cumulative Drawdown Area | Number of Known Springs and Seeps (within cumulative drawdown area) Located in Areas Where Surface Waters Potentially Could Be Impacted By Drawdown [1] |
|---|---|---|
| Willow Creek Valley | 22 | 0 |
| Rock Creek Valley | 31 | 27 |
| Boulder Flat | 122 | 74 |
| Maggie Creek | 217 | 48 |
| Marys Creek | 19 | 11 |
| Susie Creek | 126 | 22 |
| **Total** | **537** | **182** |

[1] See Figure 5-5.

## Table 5-2
## Summary of Ground Water Rights Within the Cumulative Drawdown Area

| Ground Water Basin | Domestic | Irrigation | Mining/ Milling | Municipal | Stock | Other | Total |
|---|---|---|---|---|---|---|---|
| **Ground Water Right with Current *Permit*, *Certificate*, or *Vested* Status** | | | | | | | |
| Susie Creek Area | 0 | 0 | 0 | 0 | 6 | 0 | **6** |
| Maggie Creek Area | 0 | 6 | 0 | 1 | 9 | 0 | **16** |
| Marys Creek Area | 0 | 3 | 0 | 3 | 1 | 3 | **10** |
| Boulder Flat | 0 | 39 | 10 | 0 | 21 | 2 | **72** |
| Rock Creek Valley | 0 | 0 | 10 | 0 | 1 | 0 | **11** |
| Willow Creek Valley | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| **Total** | **0** | **48** | **20** | **4** | **38** | **5** | **115** |
| **Applications for Ground Water Right and Other Known Wells** | | | | | | | |
| Susie Creek Area | 0 | 6 | 0 | 0 | 0 | 0 | **6** |
| Maggie Creek Area | 3 | 0 | 0 | 0 | 2 | 9 | **14** |
| Marys Creek Area | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Boulder Flat | 0 | 12 | 0 | 0 | 2 | 0 | **14** |
| Rock Creek Valley | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Willow Creek Valley | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| **Total** | **3** | **18** | **0** | **0** | **4** | **9** | **34** |

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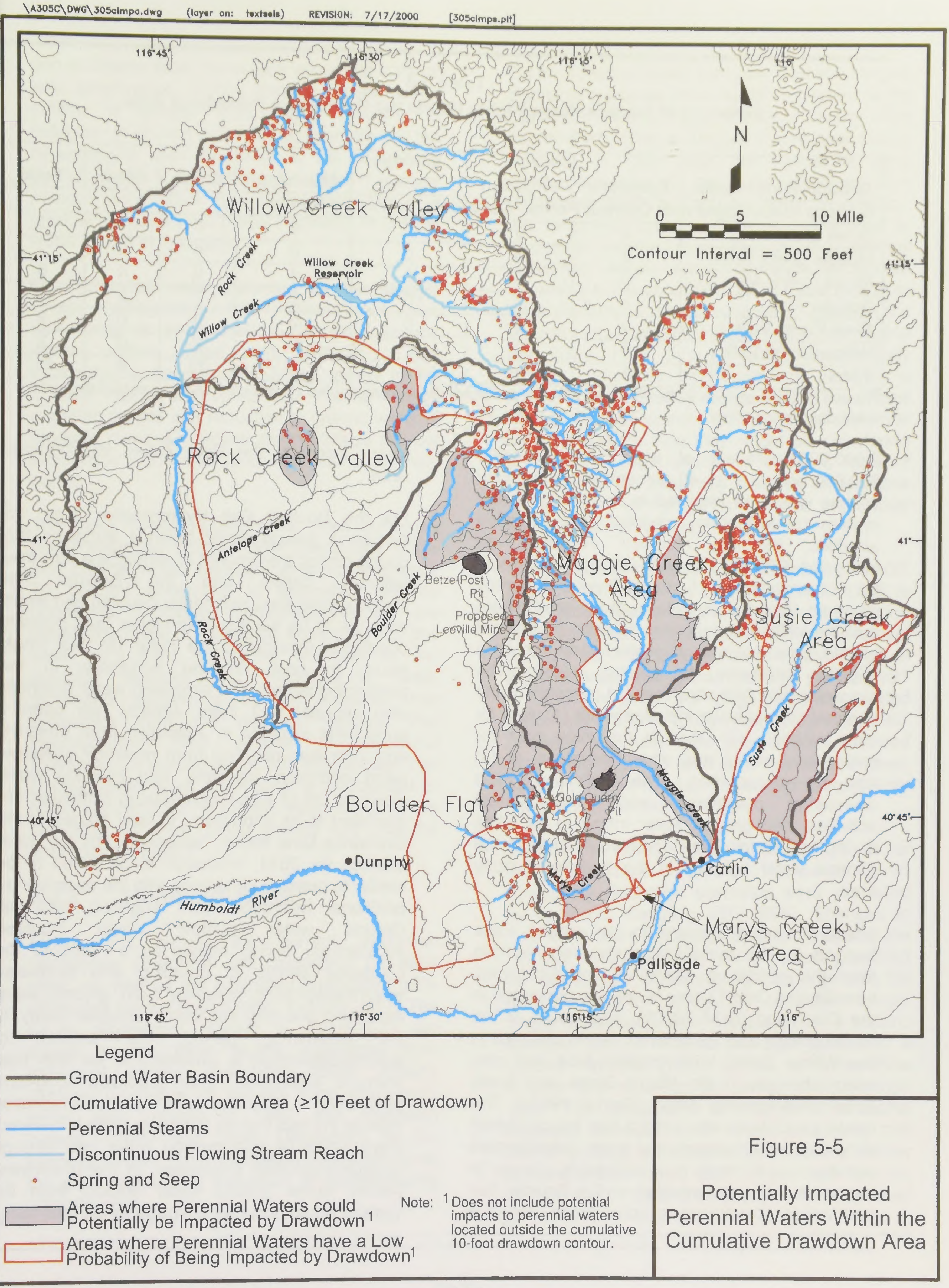


Note: [1] Does not include potential impacts to perennial waters located outside the cumulative 10-foot drawdown contour.

Figure 5-5

Potentially Impacted Perennial Waters Within the Cumulative Drawdown Area

### Table 5-3
### Summary of Surface Water Rights Within the Cumulative Drawdown Area

| Ground Water Basin | Domestic | Irrigation | Mining/ Milling | Municipal | Stock | Other | Total |
|---|---|---|---|---|---|---|---|
| **Surface Water Right with Current *Permit, Certificate*, or *Vested* Status** | | | | | | | |
| Susie Creek Area | 0 | 0 | 0 | 0 | 0 | 1 | **1** |
| Maggie Creek Area | 0 | 3 | 0 | 0 | 4 | 0 | **7** |
| Marys Creek Area | 0 | 0 | 0 | 4 | 0 | 4 | **8** |
| Boulder Flat | 1 | 7 | 0 | 0 | 7 | 3 | **18**[1] |
| Rock Creek Valley | 0 | 0 | 0 | 0 | 9 | 0 | **9** |
| Willow Creek Valley | 0 | 0 | 0 | 0 | 2 | 0 | **2** |
| **Total** | **1** | **10** | **0** | **4** | **22** | **8** | **45**[1] |

[1] Twelve of these surface water rights are primary and secondary storage at the TS Ranch Reservoir associated with mine dewatering rights.

2,000,000 acre-feet of water. An estimated 800,000 acre-feet (or 40 percent) of the pumped volume would be returned to the ground water system by infiltration activities (e.g., irrigation activities, injection, reservoir seepage); an estimated 570,000 acre-feet (29 percent) would be discharged to the Humboldt River and thereby removed from the hydrologic study area. (Note that the infiltration estimates assume 30 percent of the total volume of water used for crop irrigation infiltrates to ground water.) The remaining 630,000 acre feet (31 percent) of the pumped ground water includes water (1) used for crop irrigation, (2) used at the mine sites for mining and milling and other operations, or (3) lost by evaporation. The collective mine dewatering operations, water management activities, and ground water inflow to pit lakes during the postclosure period would change the general water balance in the hydrologic study area.

Model simulated changes in the ground water budgets for the hydrologic study area resulting from the combined effects of the Goldstrike, Leeville and Gold Quarry Mines are presented in the CIA report (BLM 2000b). The results of the model predict that there would be no changes in the Willow Creek Hydrographic Area and only minor changes in the Marys Creek and Susie Creek Hydrographic Areas (Barrick 1998c). The model simulations also predict that the combined mine-induced drawdown and water management activities would result in a noticeable change in the water balance, particularly in the Boulder Flat and Maggie Creek Hydrographic Areas, and to a lesser extent in the Rock Creek Hydrographic Area.

For the Boulder Flat Hydrographic Area, the simulated ground water balance suggests that during mining the amount of subsurface flow from adjacent basins into the Boulder Flat Hydrographic Area has nearly doubled and would continue to be substantially higher than premine conditions throughout the mine life but would return to near premine conditions in the postmining period. The simulated water balances also suggest that there already has been a substantial increase in infiltration from streams, and infiltration resulting from reservoir seepage, pond infiltration, irrigation, and injection wells. However, all of these increases in infiltration are predicted to be short-term. In later stages of the Goldstrike Mine life, as represented by the water balance for 2011, infiltration is predicted to be similar to premine conditions with the exception of additional infiltration from irrigation activities. Ground water outflow would increase substantially during mining as a result of the combined effects of pumping and increased evapotranspiration resulting from ground water mounding and crop irrigation in Boulder Valley. In the postmining period, the amount of evapotranspiration is simulated to be less than premine conditions. This predicted long-term postmining reduction in evapotranspiration reflects the fact that as the water table is lowered, there would be less ground water loss through evapotranspiration processes. In the postmining period, some ground water outflow from the system would occur as seepage for pit lake filling, and at steady state, to replace water lost from pit lake evaporation. During mining, ground water outflow is greater than inflow, resulting in reduction in ground water stored in aquifers in the hydrographic area. However, in the postmining periods, there is predicted to be approximately 4 percent more inflow than outflow, resulting in a gradual increase (and partial recovery) of ground water stored in the basin.

The simulated water balances for the Maggie Creek Hydrographic Area indicate that mine dewatering is anticipated to increase ground water outflow from the Maggie Creek Hydrographic Area during mining, mainly to the Boulder Flat Hydrographic Area. During mining, pumping results in a reduction in ground water in storage. However, reductions in storage are not anticipated within the 50-to 100-year postmining period.

The Rock Creek Hydrographic Area simulated water balances indicate both subsurface inflow and outflow would increase up to approximately 70 percent compared to estimated premine conditions. Increased subsurface inflows are largely the result of mounding expanding into this area from mine infiltration activities in the adjacent Boulder Flat Hydrographic Area. Increased subsurface outflow indicates that drawdown from the adjacent Boulder Flat Hydrographic Area results in additional movement of ground water into the Boulder Flat Hydrographic Area. Drawdown is anticipated to result in a reduction of ground water stored in this hydrographic area during mining and into the postmining period.

### 5.2.2 Humboldt River

Figure 5-6 shows the current estimated discharges (historical and projected) for each mine, as well as the estimated cumulative mine discharge for the period 1992 through 2011. The future discharges (shown in Figure 5-6) are based on the most recent projections from individual mining operations (BLM 2000b). Surface discharge of excess mine dewatering water was initiated in 1992 and increased between 1992 and 1998. Discharges to the Humboldt River have increased over time since the early 1990s to a maximum of approximately 100,000 gpm.

On an individual basis, the Lone Tree Mine began discharging excess mine dewatering water to the Humboldt River in 1992; the Gold Quarry Mine began discharging to Maggie Creek near Carlin, Nevada, in 1994; and the Goldstrike Mine discharged water to the Humboldt River from September 1997 to February 1999. In addition, the proposed Leeville Mine is anticipated to discharge to the river through the existing Goldstrike Mine water conveyance system beginning in the year 2000. All of these individual mine discharges would combine to produce the highest cumulative discharges to the river during the years 1999 through 2006. Substantially smaller cumulative discharges are planned to continue from 2007 through 2011. The mines would not necessarily discharge to the river during the entire time they would be dewatering or conducting operations. In addition, rates of discharge to the river may increase or decrease in the future as the mines continue their water management programs.

Comparison of monthly flows recorded at USGS gaging stations on the Humboldt River (1946 to 1990) with flows during the mine discharge period (1992 to 1998) indicate that for all months except January 1997 at Battle Mountain, the range of flows recorded during the discharge period (1991 to 1998) are within the range of flows recorded historically (1946 to 1990). Flows in January 1997 at Battle Mountain were greater than recorded during the premine discharge period; however, mine discharge for this period represented only 3 percent of the flow.

In order to assess future potential impacts of mine discharges to the Humboldt River, dewatering discharge scenarios were simulated by computer modeling (RTi 1998). Changes to river flows were estimated by superimposing the monthly mine flows from the maximum predicted cumulative year of dewatering discharge onto the river flows and running the computer model. These simulations were conducted for a historic low-flow year, a historic average year, and a historic high-flow year, based on streamflow records and data for the period 1946 through 1990. The simulations accounted for seasonal irrigation diversions and returns assuming that future irrigation diversion rates remained similar to those of the present day. The results presented in Figures 5-7 and 5-8 illustrate the combined

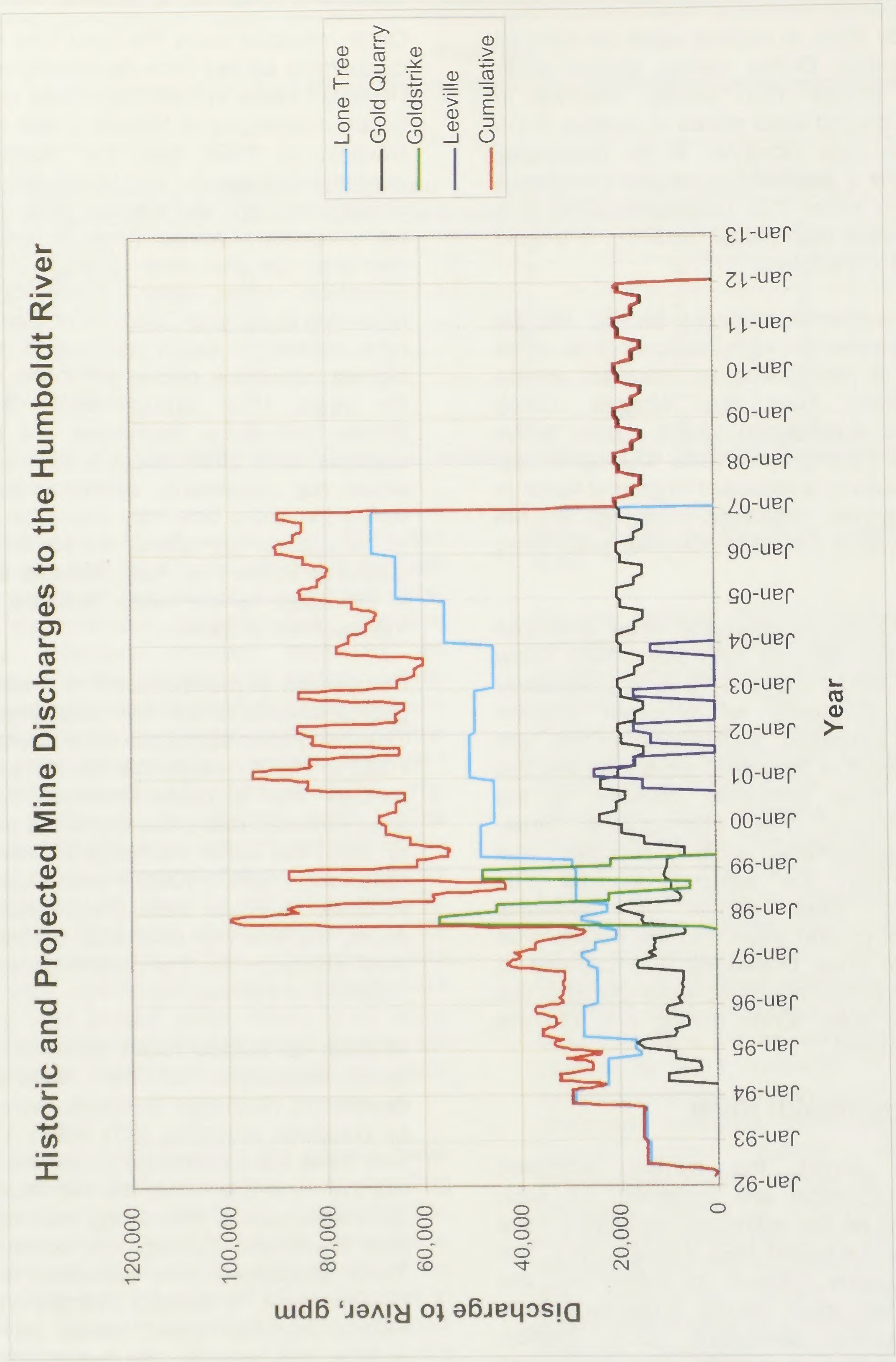
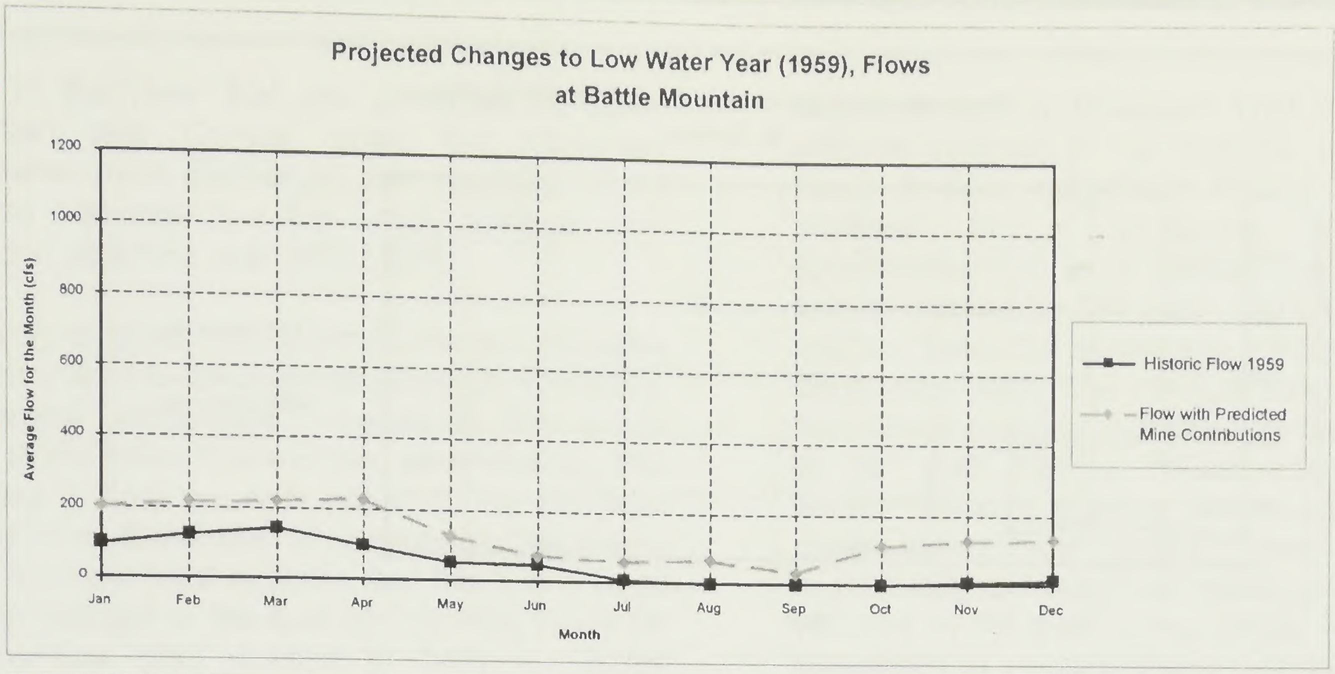
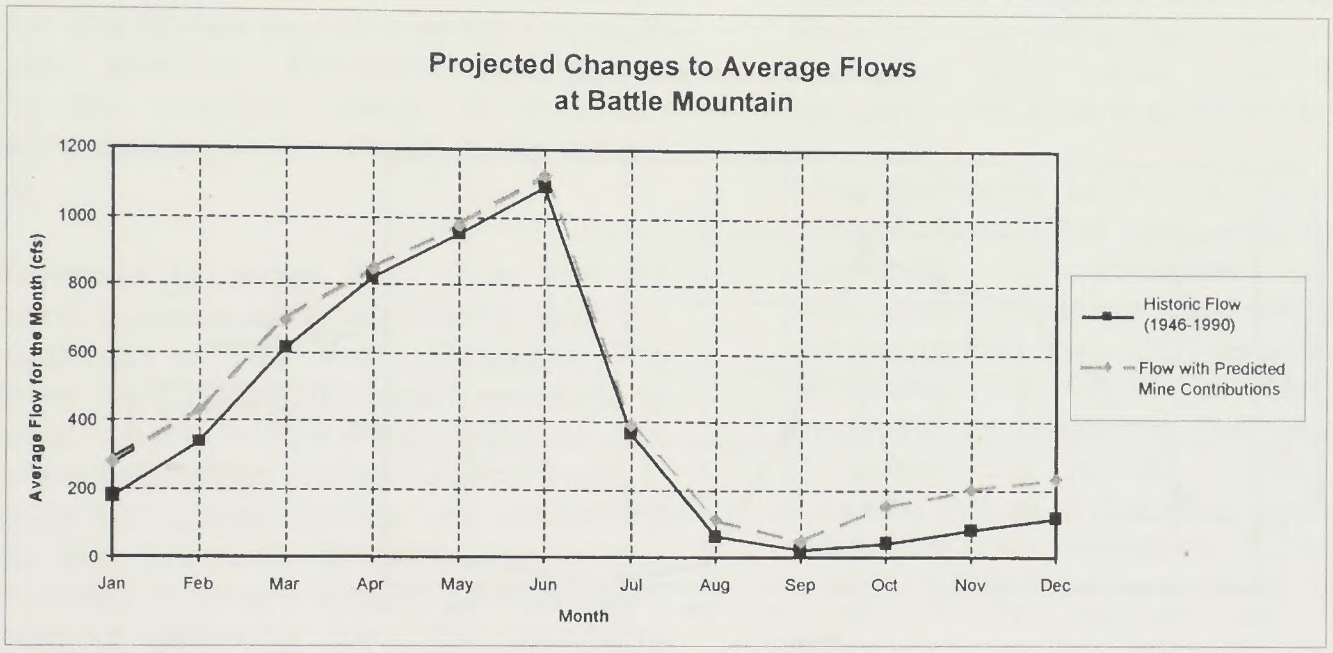


Figure 5-6

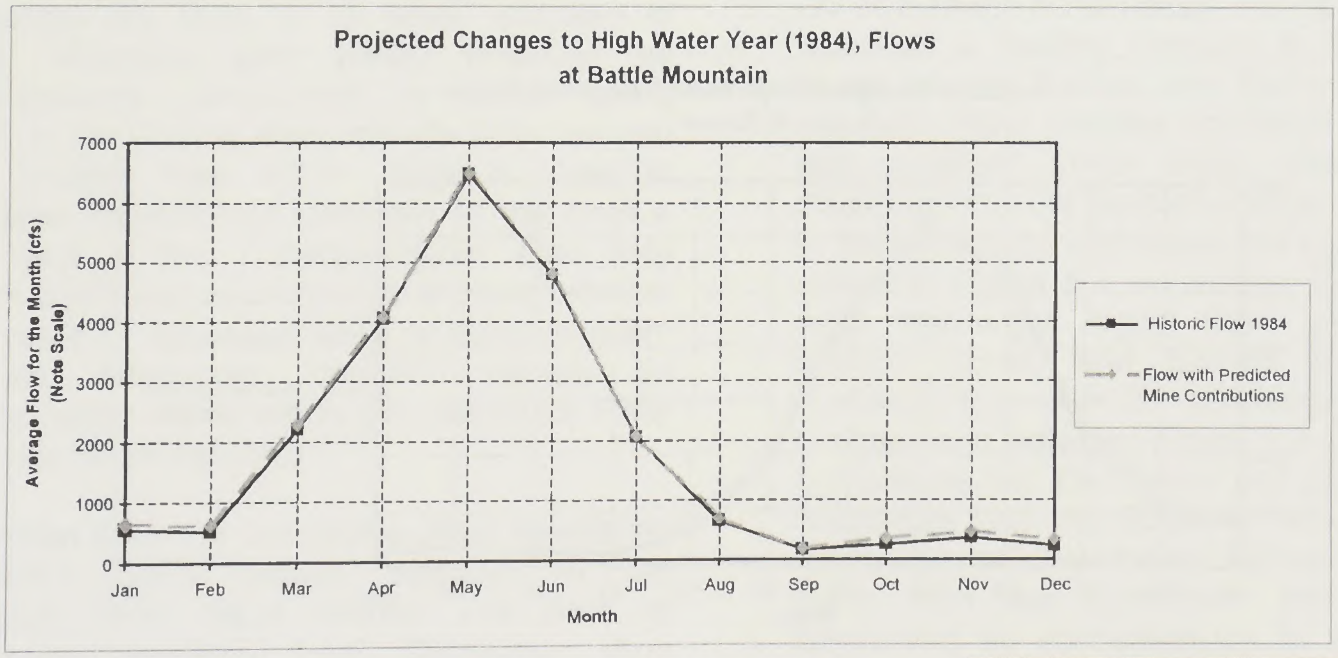
Cumulative Mining Discharges to the Humboldt River



Projected Changes to Low Water Year (1959), Flows at Battle Mountain



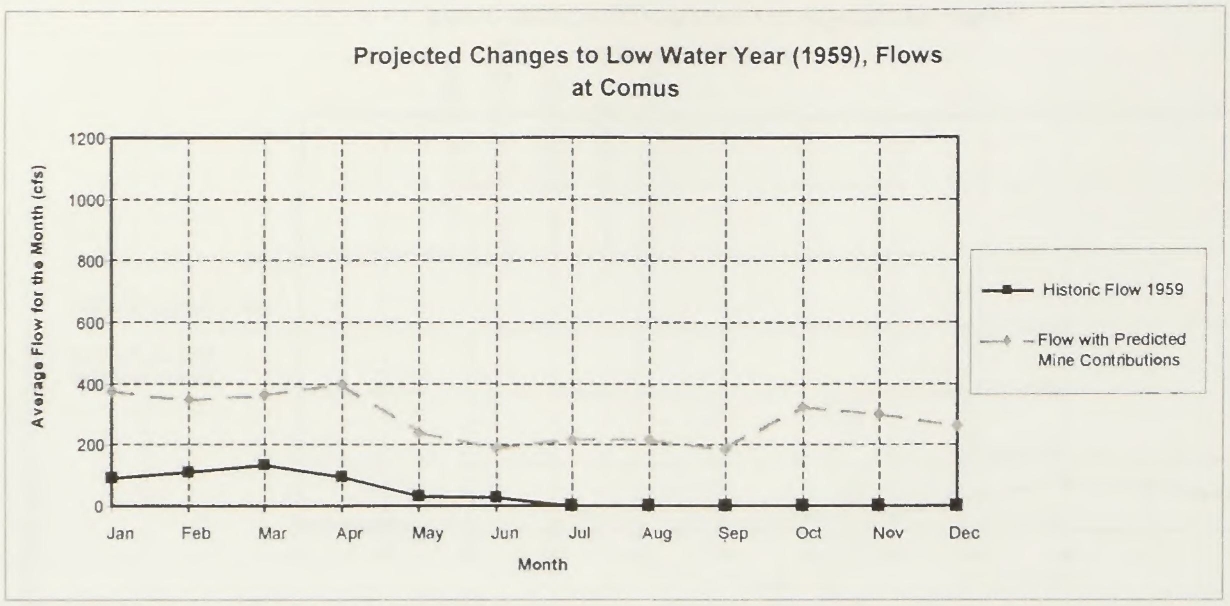
Projected Changes to Average Flows at Battle Mountain

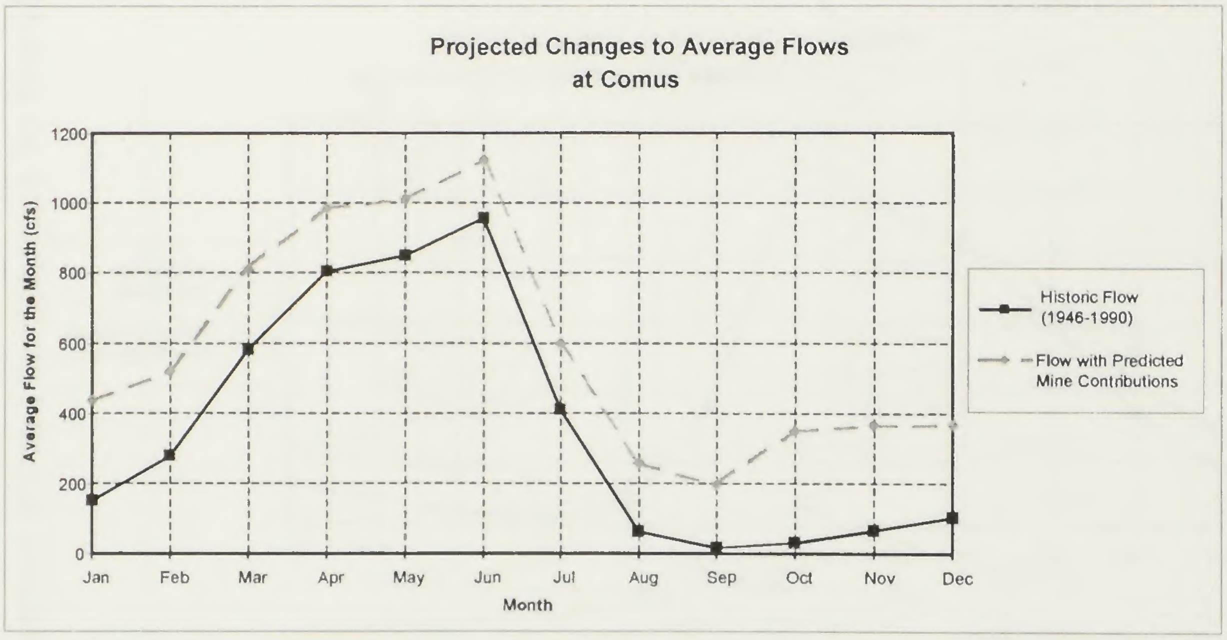


Projected Changes to High Water Year (1984), Flows at Battle Mountain

Figure 5-7

Projected Changes to Flows at Battle Mountain


Projected Changes to Low Water Year (1959), Flows at Comus


Projected Changes to Average Flows at Comus

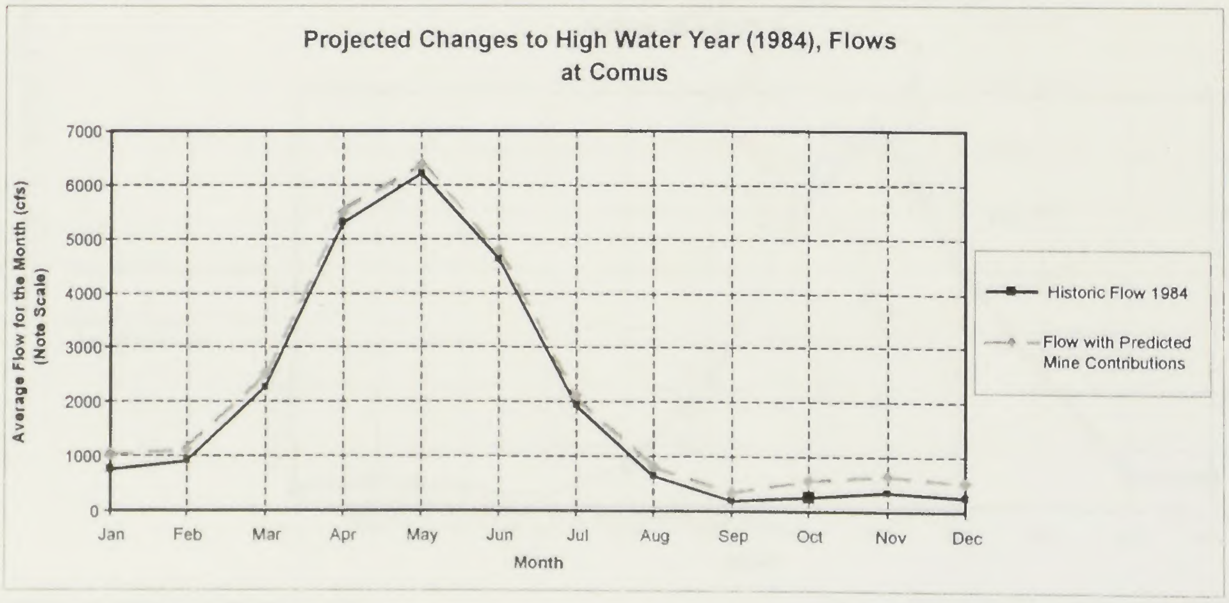

Projected Changes to High Water Year (1984), Flows at Comus

Figure 5-8

Projected Changes to Flows at Comus

flows in the river that are predicted at Battle Mountain and Comus when the maximum cumulative mine discharges are simulated along with an historical low flow year, average river flow, and high flow year (RTi 1998).

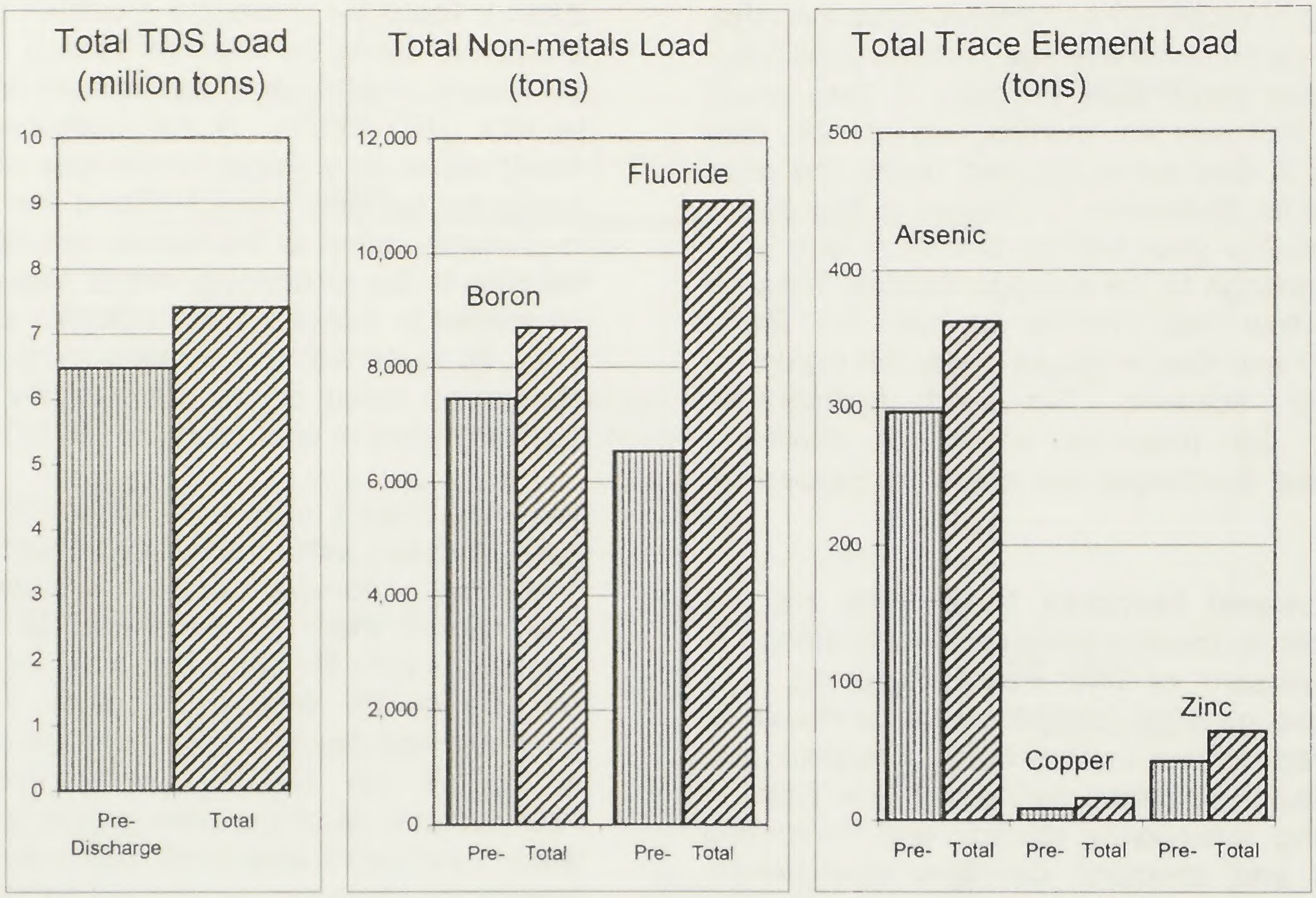
Modeling of projected future discharges indicates that compared to the average premine conditions, the largest percentage increase in flow would occur in the lower flow months, and relatively little changes in flow are anticipated during the peak flow months. Simulation of changes to flow during the a low-flow year indicate that there is a large relative change to the average monthly flows for the low-flow (fall) months at both the Battle Mountain and Comus gages under the maximum discharge scenario. Simulated hydrographs showing the projected effects of maximum cumulative discharges are shown in Figures 5-7 and 5-8.

The increased Humboldt River flows are not anticipated to create additional flooding along the river upstream of Rye Patch Reservoir. The cumulative mine discharges would contribute to the stored volume in Rye Patch Reservoir and may present difficulties during high-flow years in preserving emergency storage and minimizing flooding and structural damages downstream. Effects related to stream erosion, sedimentation, and channel geometry from the cumulative discharges are likely to be small upstream of Battle Mountain and would probably be overshadowed subsequently by natural spring runoff. In the Comus area, impacts from bed and bank erosion may occur. Irrigation diversion structures immediately upstream of the Comus gage and in the Dunphy-Argenta area may require additional maintenance or improvements as a result of increased flows or river geometry changes. Substantial long-term impacts on surface water rights within the Humboldt River basin are not anticipated.

Drawdown from the cumulative mine dewatering operations could reduce baseflow in the Humboldt River (BLM 2000b). The cone of depression resulting from Goldstrike Mine dewatering is not predicted to extend to (or result in decreased flows to) the Humboldt River; therefore, mine-induced drawdown from the Goldstrike Mine is not predicted to contribute to potential reductions in baseflow in the river. Cumulative mine drawdown from the other mine projects included in the analysis is predicted to result in flow reductions that would gradually increase to a temporary maximum of approximately 2 to 3 percent of the average annual volume by the years 2016 to 2019 (BLM 2000b). Table 5-4 shows the predicted maximum decreases during the low-flow season relative to the historic monthly average flows as determined by HCI (HCI 1997a). These reductions in flow would represent a larger percentage of the flow during the low-flow months. Flows are predicted to gradually return to the historic average annual volumes in the postmining period. Newmont has committed to mitigate these potential impacts to flows by augmenting low flows in the river (if necessary) using senior water rights that the company owns or controls (BLM 1993d).

Mine discharges to the Humboldt River have generally been within their permit limitations. One "significant non-compliance violation" was documented under the current NPDES permits; discharges from the Lone Tree Mine were in non-compliance for arsenic in early 1995, but treatment and dewatering systems were adjusted to correct the NPDES permit exceedence. Provided that all of the mine discharges remain within their permit limitations, cumulative impacts to water quality in the river are not anticipated.

On an average annual basis, the mine discharges represent a loading increase in TDS, arsenic, boron, copper, fluoride, and zinc compared with Humboldt River premine conditions. The historic and projected future loads contributed from discharge from the Goldstrike Mine are discussed in Section 3.2.2.3 and shown in Figure 3.2-44. As shown in Figure 5-9, cumulative loads from the mine discharges would likely increase TDS, arsenic, boron, and fluoride loads to the Humboldt Sink over the mine discharge period. Comparisons between Figure 3.2-44 and Figure 5-9 indicate that the historic and projected future discharges from the Goldstrike Mine represent a relatively small incremental increase of the total loads from the cumulative mine discharge. Depending on concentrations in the Humboldt Sink, parameter solubilities, and other physical and biological factors, these increased loads to the sink from the cumulative mine discharge potentially could result in increased concentrations in the sink wetlands.



Comparison of the dissolved loads without any mine discharge contribution (vertical fill) with potential total dissolved loads during the discharge period (slashed fill) over the entire historic and projected future discharge period (1992-2018) to the Humboldt Sink.[1] Note that 1) estimates of loads to the sink are based on limited premine data; and 2) actual mine contributed loads reaching the sink could be less than total potential (see BLM 2000b for additional explanation).

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[1] Assumes that the average annual pre-discharge loads, or baseline loads, carried by the river remain constant over the mine discharge period.

Figure 5-9

Potential Cumulative Increase in Loads During the Mine Discharge Period at the Humboldt Sink

Table 5-4
Projected Maximum Decreases in Humboldt River Flow
Resulting from Cumulative Drawdown
(cfs, rounded)

| Streamgage Location | July | August | September | October | November |
|---|---|---|---|---|---|
| Argenta | | | | | |
| Average Historical Flow | 332 | 38 | 13 | 22 | 58 |
| Maximum Predicted Decrease | -8 | -8 | -8 | -8 | -8 |
| Battle Mountain | | | | | |
| Average Historical Flow | 325 | 43 | 14 | 26 | 64 |
| Maximum Predicted Decrease | -8 | -8 | -8 | -8 | -8 |
| Comus | | | | | |
| Average Historical Flow | 404 | 70 | 18 | 27 | 56 |
| Maximum Predicted Decrease | -8 | -8 | -8 | -8 | -8 |

Source: HCI 1997a.

### 5.2.3 Proposed Action and No Action Alternative

No cumulative impacts to water resources are anticipated from the Proposed Action or the No Action Alternative.

## 5.3 Riparian Vegetation

Perennial creeks within the cumulative assessment area typically support a riparian zone ranging in width from a few feet immediately adjacent to the creek channel to relatively wide zones on broad floodplains. Riparian areas are valuable in providing sediment retention, nutrient removal and transformation, increased production (relative to uplands) for livestock and wildlife forage, habitat diversity for aquatic and terrestrial wildlife, and streambank stability.

Approximately 4,355 acres of riparian/wetland habitat occur within the cumulative assessment area, of which 2,025, 1,705, 228, 388, and 10 acres are associated with the Maggie Creek, Rock Creek, Susie Creek, Humboldt River watersheds, and small tributaries to the Humboldt River, respectively. Eight riparian vegetation types are present including streambar, herbaceous streambar, wet meadow, Salix streambar, Salix/wet meadow, Salix/mesic meadow, Salexi/mesic meadow, and ALNINC/mesic meadow.

### 5.3.1 Mine Dewatering and Localized Water Management Activities

The potential for impacts to riparian areas is based on the (1) predicted ground water drawdown and (2) the connectivity of the perennial streams, seeps, and springs supporting riparian vegetation with the regional ground water aquifer (see Section 5.2.1.2, Impacts to Perennial Springs and Streams).

Ground water model simulations suggest that reductions in baseflow could occur in lower Rock Creek, Boulder Creek, Marys Creek, upper and lower Maggie Creek, and lower Susie Creek. However, because of the limitations inherent in hydrologic modeling and the uncertainty regarding the hydrologic interconnection between the streams and the regional ground water system, the actual extent and magnitude of impacts to riparian vegetation are uncertain.

Approximately 600 acres (14 percent) of the 4,337 acres of riparian vegetation within the cumulative assessment area (Table 3.3-1) occur within the areas where perennial waters could be impacted by ground water drawdown. The following sections provide specific information regarding riparian vegetation that potentially could be affected by ground water drawdown by individual watershed.

#### 5.3.1.1 Maggie Creek Watershed

The Maggie Creek watershed includes approximately 47 percent of the riparian vegetation within the cumulative assessment area. The watershed supports approximately 2,025 acres of riparian vegetation, of which approximately 366 acres (18 percent) occur within areas where some impacts could occur. The majority of the riparian vegetation that occurs in areas that could be impacted by ground water drawdown is associated with Maggie Creek (246 acres), Lynn/Simon Creek (19 acres), Beaver Creek (35 acres), Coyote/Spring Creeks (15 acres), and Little Jack/Jack Creeks (20 acres). Other smaller parcels of riparian vegetation in these potentially affected areas include James Creek (5 acres), Marys Creek (10 acres), Cottonwood Creek (5 acres), Fish Creek (3 acres), East Cottonwood Creek (6 acres), and Indian Creek (1 acre).

Some of the riparian habitats associated with the Maggie Creek Watershed Restoration Project (MCWRP) are located within the area that potentially could be affected by ground water drawdown. However, impacts to these areas are not anticipated since water augmentation projects have been proposed, which are intended to compensate for the potential loss or reduction of ground water in the area.

#### 5.3.1.2 Rock Creek Watershed

The Rock Creek watershed includes approximately 39 percent of the riparian vegetation within the cumulative assessment area. This watershed includes approximately 1,685 acres of riparian vegetation, of which approximately 228 acres (14 percent) occur within areas that could be impacted by drawdown. Riparian vegetation that could be affected by ground water drawdown is associated with Boulder Creek (148 acres), Antelope Creek (70 acres), and Welches Creek (10 acres).

#### 5.3.1.3 Susie Creek Watershed

The Susie Creek watershed includes approximately 228 acres of riparian vegetation, of which approximately 1 acre (less than 1 percent) is within areas that potentially could be affected by ground water drawdown. Riparian vegetation that could be affected by ground water drawdown is associated with Middle Susie Creek.

#### 5.3.1.4 Small Tributaries to the Humboldt River

These tributaries support approximately 10 acres of riparian vegetation, of which approximately 4 acres (40 percent) are within areas that potentially could be affected by ground water drawdown. Riparian vegetation that could be affected by ground water drawdown is associated with Dry Susie Creek.

#### 5.3.1.5 Humboldt River

The Humboldt River includes approximately 388 acres of riparian vegetation with a low probability of being affected by ground water drawdown.

Exposed channel sediments during reduced baseflow periods would be prone to invasion by noxious weeds. Noxious weed species, including Scotch thistle, Canada thistle, leafy spurge, whitetop, water hemlock, diffuse knapweed, and Russian knapweed that have been observed in the SOAPA study area, could become established within these channels (BLM 2000b). Riparian vegetation would likely dominate these areas after water levels returned to premine conditions.

#### 5.3.1.6 Isolated Springs and Seeps

Approximately 60 isolated springs and seeps, that are not associated with perennial stream reaches, occur within areas where perennial waters could be impacted by drawdown (see Figure 5-5). Based on the SOAPA Draft EIS (BLM 2000a) and the 1993 SOAP EIS (BLM 1993b), the majority of wetlands observed within the Maggie Creek basin range from 0.1 acre to 1.0 acre in size. Assuming that each spring supports an average of 0.3 acre of wetland vegetation, an estimated 18 acres of wetland vegetation occur within areas where perennial waters could be impacted. Therefore, the amount of wetland vegetation in these areas could be reduced.

In summary, according to ground water modeling and associated water resources analyses, approximately 600 acres of riparian vegetation associated with perennial stream reaches and 18 acres of wetland vegetation associated with isolated seeps and springs are located within areas where some reduction in flow could occur. Therefore, riparian and wetland vegetation within these areas could be reduced.

### 5.3.2 Humboldt River

Natural fluctuations in water levels caused by seasonal variations and flood and drought events greatly influence the distribution and extent of riparian vegetation established within the Humboldt River floodplain. As described previously, additional mine discharges would increase temporarily and mine-induced drawdown would then decrease flows in the Humboldt River. These anticipated water level changes potentially could affect channel configuration, depth, and sinuosity that directly affect the distribution and extent of riparian vegetation.

In general, the peak flow months (i.e., May and June) would not be affected by the additional discharge. Relative to the natural fluctuations in river flows during these months, the increases would be small and would have no impact to the flow regime of the Humboldt River during average peak flow months. Water discharges into the river could result in a substantial increase during low-flow periods. During low-flow periods (September to November), the average water depth could increase approximately 1.5 feet (0.7 to 2.2 feet), and channel width could increase approximately 35 feet (45 to 80 feet) under the maximum combined discharge scenario.

Effects from increased water levels during baseflow periods include an increase in elevated water table in low-lying areas located adjacent to the river, increasing the frequency of flooding of stream meanders and oxbows. Riparian/wetland plants could become established in areas where the water table is elevated to the rooting depths needed for riparian/wetland plant establishment. Stream meanders and oxbows could be more frequently subjected to flood events, further enhancing the potential for riparian/wetland plant establishment. Increased baseflows and slightly increased peak flows could facilitate the establishment of willows along the main river channel and side channels since the water levels would be more constant throughout the year. Increases in the extent of riparian vegetation would be most noticeable along segments of the river with gradual banks and low-lying areas located adjacent to the river. These areas could be more frequently flooded during peak flows, and the water table could be shallow due to increased baseflows.

An additional effect resulting from increased water levels during low-flow periods would be the potential for restoring or enhancing specific wetland and marsh habitats in Herrin Slough. Riparian/wetland areas currently present in Herrin Slough, which consists of a series of low-gradient channels, could be enhanced by increased baseflows and slightly elevated peak flows. Water levels in Upper and Lower Pitt-Taylor Reservoirs could become more consistent, which would improve conditions for wetland and aquatic plant establishment.

Additional effects may include channel instability in the reach extending approximately 3 miles upstream and downstream from the Barrick outfall, deepening of the river channel, and loss of streamside riparian vegetation due to increased erosion and destabilization of stream banks.

Although cumulative water drawdown may eventually reduce the Humboldt River baseflow after the mines' dewatering discharges cease, the mine-induced drawdown from the Goldstrike Mine is not predicted to contribute to the potential reduction in the river's baseflow.

Small, isolated stands of wetland vegetation that occur along the banks of Rye Patch Reservoir would likely be lost if water levels were consistently high within the reservoir during periods of high water discharge. As a result of consistently high water levels, wetland vegetation could be lost to inundation. Steep banks immediately adjacent to the reservoir would make it difficult for wetland vegetation to become re-established. Wetland vegetation would not become established until water levels were comparable to pre-discharge water levels.

Depending on irrigation withdrawals and returns during the period of discharges, the areal extent of wetland vegetation within the Humboldt Sink could increase as a result of higher and more consistent water levels. Consistent high water levels in the Humboldt Sink could flood and kill stands of salt cedar. Portions of the sink that were seasonally flooded would likely be perennially inundated, resulting in the temporary loss of emergent wetland vegetation until it becomes established along the margins of the sink. Dense stands of salt cedar could become re-established on exposed sediments during low-water periods. Increased water levels also would increase the extent of open water habitats that would facilitate aquatic plant establishment. These effects would subside when mine discharges cease. Excess water from the Humboldt Sink may occasionally reach the Carson Sink during high-water periods. The Carson Sink is a shallow, highly alkaline playa lake that primarily supports salt-tolerant upland species. However, the occasional influx of water conveyed to the Carson Sink would not result in the establishment of wetland plants.

### 5.3.3 Proposed Action and No Action Alternative

No cumulative impacts to riparian vegetation or wetlands would result from the Proposed Action or the No Action Alternative.

## 5.4 Terrestrial Wildlife

### 5.4.1 Mine Dewatering and Localized Water Management Activities

The ground water drawdown from the mines' dewatering activities could result in a long-term reduction in the amount and extent of available surface water and associated riparian, wetland, and mesic habitats within portions of the cumulative assessment area for a number of terrestrial wildlife species. Approximately 618 acres of riparian/wetland habitats are located in areas associated with isolated springs and seeps and perennial streams that could be affected by the cumulative ground water drawdown (Section 5.3). No estimates for possible effects to mesic habitats were developed. Sections 5.2 and 5.3 discuss these isolated areas that could be affected by ground water drawdown.

Reduction in surface or subsurface flows could result in effects ranging from reduced plant vigor to the total loss of riparian vegetation cover, depending on a number of hydrological and geological factors. Potential reduction or loss of available water or possible long-term effects to the riparian community could result in a loss of breeding, foraging, and cover habitats; reduction in available water for consumption; increased animal displacement and loss; reduction in prey availability; reduction in the overall biological diversity; possible genetic isolation; a reduction in the regional carrying capacity for terrestrial wildlife; and possible population declines, depending on the level of effects and the relative species' sensitivity. Assuming that these limited riparian communities are currently at their respective carrying capacities, individuals that are displaced into adjacent communities may be lost from the population, concentrating the remaining animals within smaller habitat areas. Incremental habitat loss would affect a variety of big game, upland game birds, waterfowl, shorebirds, raptors, songbirds, nongame mammals, area reptiles, and amphibians. The recovery of ground water and surface water sources would be gradual.

The reduction or loss of existing water sources could impact big game use and movements. The greatest impacts to mule deer from cumulative drawdown would be a reduction or loss of available water on important transitional ranges and a small portion of winter ranges. Since a small number of deer also use these winter and transitional ranges during the summer, water availability for mule deer could be affected in some areas year-round. Pronghorn ranges that may be affected by the cumulative loss or reduction of perennial water sources would encompass portions of summer, winter, and transitional ranges. Effects to available water would incrementally reduce the range's carrying capacity, displacing deer and pronghorn into adjacent ranges that may not support additional herd numbers. Relative to mine discharges, spring runoff coupled with water discharged from mining activities in Maggie Creek could impede deer and pronghorn movements between seasonal ranges. Only a small portion of bighorn sheep range would likely be affected from cumulative ground water drawdown. The areas potentially impacted by drawdown intersect a small area of yearlong range for bighorn sheep.

A reduction in the riparian community would ultimately affect the amount of nesting habitat for mourning doves and both potential brooding and foraging habitat for doves, sage grouse, and chukar. A decline in surface water availability would result in incremental habitat loss and displacement of individuals. Displacement could result in the loss of these individuals, assuming that adjacent communities are currently at their respective carrying capacities. A reduction in riparian vegetation also could be a limiting factor in brood rearing during the later summer when food sources, such as upland forbs, may decline due to dry conditions. Sage grouse are discussed in Section 5.6.1 for special status species.

Water birds associated with the larger spring sites in the foothill regions of the cumulative assessment area and the perennial portions of streams that support adequate riparian habitat and pools for foraging and cover may be affected by cumulative ground water drawdown. The long-term reduction or loss of available surface water and associated emergent plants in these naturally occurring wetland areas currently used by water birds would result in the displacement or loss of these birds.

The eventual reduction in flows within the three artificially created wetlands in Boulder Valley would result in a transition back into an upland plant community. It is anticipated that the number and species of water birds that use these artificial wetland communities would decline, particularly as the drier, more upland habitats began to re-establish in the valley. Based on current observations, it appears that saturated soils are increasing the leaching of minerals and salts into the soil surface and subsurface layers. The eventual transition to a plant community of more salt-tolerant species would result in changing wildlife composition for this area of Boulder Valley in the long term.

Potential long-term impacts to raptor species could include loss of potential nesting, roosting, and foraging habitat along the perennial drainages and at the seeps and springs affected by cumulative ground water drawdown. These losses would result from an incremental reduction in available habitat for both resident and migratory raptor species. The reduction in riparian-dependent prey species within the area potentially affected by drawdown could possibly force birds to forage more within the upland habitats, which are not as diverse as the riparian communities. The habitat carrying capacity for raptors also would be reduced by the incremental loss of available nest and roost sites. Some raptors are closely associated with riparian habitats large enough to support trees and increased shrub density. Other species may use these trees for roosting only, but the cumulative drawdown area has limited vertical diversity in plant structure. Therefore, these roost sites are important, particularly for hunting activity.

The potential short- and long-term effects to both resident and migratory songbird species (including neotropical migrants) from cumulative ground water drawdown would parallel those discussed for upland game bird and nongame raptor species. Those songbirds that generally depend on open water and riparian habitats for breeding, foraging, or resting during migration would be the most affected. The incremental loss of riparian or emergent habitats would result in bird displacement and possible reduction in local avian population numbers. Migrant songbirds also may be displaced or otherwise affected by a reduction in riparian habitat. The potential for population-level impacts to occur from cumulative ground water drawdown would depend on the relative species' sensitivity, rarity, and habitat associations.

### 5.4.2 Humboldt River

Water discharges into the Humboldt River would result in a net increase in water, even with additional water use by existing water rights holders for irrigation purposes. A net increase in flows within the river system would increase the overall water availability for consumption for a variety of wildlife species including mule deer, waterfowl, shorebirds, songbirds, raptors, beaver, river otter, and other terrestrial species that are closely associated with these river communities. Increased flows may better support existing plant communities of willow, wild rose, cottonwoods, and emergent vegetation (e.g., bulrush, cattails) immediately adjacent to the river channel, particularly during the low-flow periods. Additional water levels along existing river meanders and old oxbows that currently do not receive sufficient water during high-flow periods could help to establish on-channel ponds and support valuable riparian or wetland vegetation which provides important nesting, brooding, foraging, and resting habitat for many terrestrial wildlife species. These potential short-term effects would be most apparent during the low-flow period (October through February). Potential effects from seasonal flooding would include a possible loss of available nesting and foraging habitat for some species; however, this impact would be offset by the creation and enhancement of the backwater and slough areas along the river corridor. Increased annual flows may result in additional open water during the winter season, consequently improving foraging opportunities for species such as wintering bald eagles.

Although cumulative ground water drawdown may eventually reduce the Humboldt River baseflow after the mines' dewatering discharges cease, the mine-induced drawdown from the Goldstrike Mine is not predicted to contribute to the potential reduction in the river's baseflow.

Temporary increases in flows into the Humboldt Sink (including the Humboldt Wildlife Management Area) would improve breeding, foraging, and resting opportunities for resident and migratory waterfowl and shorebird species in the short term. In turn, the improved habitat conditions for these species would increase the relative prey availability for area predators. The dynamic wetland system of the Humboldt Sink is characterized by both wet and dry cycles. Additional water flowing into the Humboldt Sink and possibly the Carson Sink would provide additional habitat for wildlife. However, inundation of some habitats also would temporarily reduce the amount of available nesting habitat for some shorebird species, such as the American avocet, black-necked stilt, and other species that nest either on emergent vegetation or along the margins of wetland communities. This potential loss of available nesting habitat for certain bird species would be expected to be short-term, since the water levels would fluctuate and emergent vegetation would re-establish along the wetland borders.

Possible exposure risks of avian and mammalian wildlife species to metals and other constituents would be similar to levels recorded for premining conditions. These potential risks are anticipated to be minimal. However, the dynamic nature of the Humboldt Sink's water system, influence of upstream water demands, fluctuations in water levels, bioaccumulation factors for some metals, and a number of environmental variables (e.g., wind deposition of salts) make it difficult to predict future long-term exposure risks to the biota.

### 5.4.3 Proposed Action and No Action Alternative

The cumulative impacts to terrestrial wildlife species from implementation of the Proposed Action would be limited to the short-term, incremental disturbance of the sagebrush/grassland community within Boulder Valley. This disturbance would result in short-term animal displacement and reduction in potential habitat for the upland species that typically occupy this habitat type in conjunction with other surface disturbances caused by mining activities, livestock grazing, and agricultural operations in the valley. However, the temporary and limited nature of the surface disturbance caused by the Proposed Action would be expected to be minimal, based on Barrick's proposed reclamation. No cumulative impacts to terrestrial wildlife from the No Action Alternative would be anticipated.

## 5.5 Aquatic Resources

### 5.5.1 Mine Dewatering and Localized Water Management Activities

Cumulative impacts predicted for aquatic resources are based on the results of cumulative hydrologic modeling analyses. Mine dewatering from the cumulative project operations could reduce water levels or flows in some springs and perennial reaches within the Maggie Creek, Susie Creek, Marys Creek, Boulder Creek, and Rock Creek drainages. However, the ground water analyses predicted that the Goldstrike Mine would contribute to potential cumulative flow reductions in the Boulder Creek drainage, upper Antelope Creek, and lower Rock Creek (see Section 5.2.1.1, Impacts to Ground Water Levels). It is important to note that the model-predicted surface water reductions are uncertain. If any perennial streamflows are decreased, the effect on the aquatic resources would be a reduction of the associated aquatic habitats. These habitats would support periphyton and invertebrates and, depending on where they occur, could support Lahontan cutthroat trout (see Section 5.6.2) and other native fish species. Water level reductions in springs would affect periphyton, macroinvertebrates, and native fish species (if present). Habitat reductions would likely result in decreased numbers in these communities. If stream segments become dry as a result of reduced flows, aquatic habitat and associated biota would be eliminated. Drawdown of the water table would continue to expand and reach a maximum at approximately 100 to 170 years during the postmining period. Afterward, there would be a gradual recovery of the aquifer and associated surface waters.

Any surface water impacts on the eastern side of the Tuscarora Mountains would likely occur in water bodies located at lower elevations; these lower elevation waters are likely connected to the regional aquifer and could be affected by the dewatering activities. The higher elevation waters are thought to be isolated from the deep aquifer that is being affected. As a result, these higher elevational waters (and their associated aquatic communities) are not predicted to be impacted by the dewatering activities.

### 5.5.2 Humboldt River

The effects of flow increases would affect aquatic communities in the Humboldt River. Discharges to the river would increase the habitat for fish, macroinvertebrates, and periphyton. However, the possible reduction of shallow pools and braided channels could adversely affect the development of young fish. Increased flows also could result in fish composition changes, as introduced species would be able to disperse and utilize wider areas of the river and likely compete with native species. Overall, the effects of increased flows on water quality conditions would be minor. Water quality analyses indicated that dissolved arsenic, boron, and fluoride loads could increase in the Humboldt Sink. It is possible that metals could increase in sediments, but data are not available to quantify the potential changes. It is possible that increased sediment levels may affect aquatic biota in sections of the river near the Barrick outfall and Comus gage.

The Goldstrike Mine would not contribute to potential flow reductions in the Humboldt River during the postmining period. Therefore, no cumulative effects would occur for aquatic communities during postmining.

### 5.5.3 Proposed Action and No Action Alternative

No cumulative impacts to aquatic resources would be associated with the Proposed Action or the No Action Alternative.

## 5.6 Threatened, Endangered, Candidate, and Sensitive Species

### 5.6.1 Terrestrial Species

Potential cumulative impacts to the special status species identified for the cumulative assessment area from the mines' dewatering activities would parallel the impacts discussed for terrestrial and aquatic wildlife resources (Sections 5.4 and 5.5), encompassing habitat loss, increased displacement, loss of individuals, reduced prey availability, reduced diversity, possible genetic isolation, and potential population declines, depending on the extent of effects, whether a species is present, and the relative species' sensitivity. The potential impacts to each species as a result of the cumulative dewatering and water management activities are discussed below.

Potential exposure to constituents of concern at the Humboldt Sink parallel the risks discussed for general wildlife species, if any of the following special status species that may occur in or near the Humboldt Sink were present: the Preble's shrew, six sensitive bat species identified for the projects, bald eagle, golden eagle, northern goshawk, Swanson's hawk, ferruginous hawk, osprey, American white pelican, white-faced ibis, and black tern. It has been estimated that the possible exposure risks to metals and other constituents would be similar or the same as those for premining conditions. However, a number of both environmental and man-induced variables make it difficult to predict future long-term exposure risks.

The extent of available surface water and riparian habitats could be reduced within the cumulative assessment area, encompassing 18 acres of riparian and wetland habitats associated with isolated springs and seeps and 600 acres of habitat along perennial stream reaches encompassing upper and lower Maggie Creek, lower Susie Creek, Marys Creek, Boulder Creek, and lower Rock Creek.

The potential cumulative long-term loss of some seeps, springs, and stream reaches within the areas of potential impact to perennial surface waters could reduce the amount of potentially suitable habitat for the Preble's shrew. It is anticipated that increased flows in the Humboldt River and Humboldt Sink would provide additional water to support existing riparian and wetland communities during the mines' discharge period, which would provide additional potentially suitable habitat for this shrew species.

The potential reduction or loss of perennial surface water resources and surrounding riparian vegetation as a result of cumulative ground water drawdown could affect the six special status bat species (including the two subspecies of the Townsend's big-eared bat), incrementally reducing the amount of suitable foraging habitat for a number of these bat species. However, the vegetation density relative to the amount of open water combined with the proximity of possible foraging areas to occupied bat roosts would determine overall habitat values for bats and the extent of anticipated habitat losses or reduction in foraging opportunities. No impacts to bat hibernacula or other communal roosts would be anticipated, since it is assumed that these larger roost sites occur in caves, buildings, or large rock outcrops. Increased flows along the Humboldt River and Humboldt Sink would create additional foraging areas for bats, in the form of increased surface water area and improved riparian habitats.

The cumulative reduction in perennial surface water within the regional hydrologic study area would incrementally reduce the potential amount of available foraging habitat for wintering and migrating bald eagles. However, potential habitat effects would be minimized, based on the low number of wintering eagles that typically occur in the area and the use of both open water areas and upland habitats for foraging. In addition, no drawdown impacts are anticipated for the Willow Creek Reservoir, a prominent site for eagles, and there are no known communal or historic roost sites within the study area. Potential effects to bald eagles that occur along the Humboldt River and Humboldt Sink during the mines' water discharges would parallel the effects discussed for general wildlife resources (Section 5.4). Increased water levels would be most apparent during the low-flow periods, resulting in more open water (less freezing) during the late fall and winter and a greater prey abundance.

Potential cumulative impacts to the golden eagle that could occur from the reduction or loss of riparian or wet meadow habitat types would be limited to an incremental reduction in potential foraging areas, if available surface water and associated riparian vegetation were affected by long-term ground water drawdown. However, this raptor predominantly nests and forages in drier, upland areas, and use of riparian drainages and wet meadow areas would be sporadic. An overall increase in water availability and maintenance or enhancement of riparian vegetation from increased water levels in the Humboldt River and in the Humboldt Sink would result in an associated increase in small mammal populations, incrementally increasing the quality of foraging habitat and opportunities.

Potential cumulative long-term effects to goshawks could result from reduction or loss of riparian habitats associated with perennial water sources at the higher elevations within the cumulative assessment area. However, the majority of these high-elevational springs and streams would not be impacted. Impacts to nesting and foraging goshawks would be limited to perennial water sources that support suitable trees for goshawk nest sites and sufficient vegetation for the smaller birds and small mammals that comprise this accipiters primary prey species. The potential effects from changing flows in the Humboldt River and Humboldt Sink would only apply to wintering goshawks, since the Humboldt River Valley occurs at lower elevations than those typically occupied by nesting goshawks.

The likelihood of Swainson's hawks nesting and foraging within the cumulative assessment area is low, based on this species' current distribution in northern Nevada. Since this hawk species may occupy both upland and riparian areas for nesting and foraging, a potential reduction in available water and/or riparian vegetation could incrementally impact this species' nesting sites and foraging areas. A reduction in potential prey abundance (from invertebrates to small vertebrates) may affect this species' distribution and habitat use in northern Nevada, if present. Increased water levels in the Humboldt River and Humboldt Sink and maintenance or enhancement of associated riparian habitats could result in a correlated increase in potential prey species for both breeding and migrating Swainson's hawks.

A cumulative long-term reduction or loss of riparian habitats may indirectly affect the ferruginous hawk. The success of nesting raptors is often closely associated with the available prey base and relative prey densities, and prey availability is particularly important for nesting ferruginous hawks. Also, since concentrations of ferruginous hawks may use wet meadows as staging areas prior to fall migration, prey abundance in these wet meadow habitat types may be important to both migrating and nesting birds. Reduction or loss of wet meadow or riparian habitats from the cumulative drawdown effects could remove habitats for suitable prey, thereby reducing prey abundance and possibly affecting subsequent ferruginous hawk nesting success. Increasing flows within the Humboldt River and Humboldt Sink may increase prey abundance (small mammals commonly occupying wet meadow or mesic habitats) for ferruginous hawks.

No cumulative impacts to the osprey would be anticipated from the potential long-term reduction in available surface water seeps, springs, or small streams throughout the cumulative assessment area, since this rare migrant generally is associated with large reservoirs, lakes, and rivers. As discussed for the bald eagle, no effects to Willow Creek Reservoir are expected, and the possibility of individual migrating osprey foraging along the smaller creeks or springs is low. The potential increase in available water in the Humboldt River during the mines' discharge period may result in increased foraging opportunities for migrating individuals of this primarily fish-eating species.

Based on the burrowing owl's known habitat associations, it is assumed that breeding adults and young predominantly occupy dry, upland communities. However, since mesic and riparian habitats often provide a greater diversity and abundance of terrestrial invertebrates, it is feasible that adult owls would forage within these areas, particularly during the brood-rearing period. No cumulative impacts to this species' dry, upland nesting habitats would be anticipated. Potential impacts to the burrowing owl from increased water levels in the Humboldt River would be expected to be limited to an incremental increase in possible foraging habitat, though use of the river corridor likely would be sporadic and isolated.

A potential cumulative reduction in naturally occurring seeps, springs, and perennial stream reaches and their associated riparian and mesic communities could ultimately affect the amount of potential brooding and foraging habitat for sage grouse. This incremental habitat loss would be long-term, and it is assumed that the birds that are closely associated with these habitat types would be displaced or lost. In the event that perennial flows were reduced, the riparian vegetation would likely decrease, reducing the vegetative structure, composition, and diversity. As an aid in characterizing the overall distribution and concentration of lek sites, a total of 14 historic leks were documented in the cumulative drawdown area. Of these 14 leks, 11 are located in areas where perennial surface waters potentially could be affected. An additional 3 leks have been documented within 2 miles of these perennial waters, and another 5 leks are within 2 miles of the cumulative drawdown boundary.

No direct impacts to active or potential lek sites would be anticipated, since leks generally occur in more upland communities (although they are often adjacent to intermittent or perennial drainages). However, there is a potential that nesting and brood-rearing areas could be affected in riparian, wetland, and mesic habitats that could be impacted by cumulative ground water drawdown, particularly in the mid- to late summer, as the upland forbs desiccate and the broods depend more on the mesic and riparian habitats. Because these brood-rearing areas could be located several miles from leks and nesting areas within the drawdown area, it is difficult to quantify the amount of habitat that could be affected. However, it can be stated that the loss of riparian, wetland, or mesic habitats due to drawdown in these areas would reduce the amount of possible nesting and brood-rearing habitat available, altering sage grouse distribution during summer and autumn and possibly reducing the total sage grouse population.

As discussed for the osprey and bald eagle, no impacts to large bodies of water (e.g., Willow Creek Reservoir) are currently anticipated that could support foraging American white pelicans. Since this species is closely associated with lakes or ponds, no cumulative impacts to migrating pelicans would be anticipated from future changes in water levels or riparian habitats in the mine areas or along the Humboldt River.

If present within the cumulative assessment area, individual white-faced ibis and black tern would likely use the larger spring sites in the foothills region of the mountain ranges and the perennial portions of streams that support adequate riparian habitat and pools for foraging and cover. The cumulative reduction or loss of available surface water and associated emergent plants in these naturally occurring wetland areas would result in the displacement or loss of breeding or foraging; however, no population-level impacts would be anticipated. As the mine discharges diminish in the future, the artificially created wetlands in Boulder Valley would be reduced, as well. The level of available surface water, in addition to the associated riparian and wetland vegetation, would slowly decline, with the drier, more upland communities becoming re-established. However, it presently appears that previously saturated soils have increased soil leaching of salts and minerals. This leaching process would ultimately result in a transition of the present plant communities to a community that supports more salt-tolerant plants. This transition would result in both decreased plant and wildlife species diversity. At this time, the dry alkaline soils and vegetation would not be suitable for use by either the white-faced ibis or black tern. Increased flows in the Humboldt River and in the Humboldt Sink during the mines' discharges would result in an increase in potentially suitable habitat for these two water birds.

Because the Nevada viceroy is associated with willows below 6,000 feet elevation, cumulative surface water reductions that would affect the maintenance of willow communities would reduce the amount and quality of habitat for this species. Therefore, a reduction in surface water from drawdown may reduce willow development, which would affect Nevada viceroy habitat. Increased flows in the Humboldt River due to mine-water discharges could increase riparian habitat (and associated Nevada viceroy habitat) in the short term during mine discharge.

Cumulative impacts to Lewis buckwheat are not anticipated as a result of ground water drawdown since this species is associated with upland habitats and is dependent on seasonal precipitation.

### 5.6.2 Aquatic Species

Hydrologic modeling predicts cumulative ground water drawdown in areas where surface water flows (and associated LCT habitat) could be reduced, including the lower sections of Little Jack, Coyote, and Beaver creeks (Figure 5-5). However, the ground water drawdown associated with Goldstrike Mine is not predicted to contribute to potential flow reductions in these stream sections or other surface waters occupied by LCT in the Maggie Creek drainage. In addition, the Goldstrike Mine is not predicted to contribute to flow reductions in Susie Creek, which has been identified as a potential LCT re-introduction stream (Coffin and Cowan 1995).

The Goldstrike Mine may contribute to flow reductions in lower Rock Creek, where California floaters have been found. This project is not predicted to contribute to flow reductions in other stream segments in the Maggie Creek drainage where California floater have been collected. Impacts in lower Rock Creek would depend on the amount of surface water reduction and could range from slight reduction to complete elimination of the California floater habitat in this stream segment.

Springsnail populations are known to occur at six springs in upper Antelope Creek, one spring in upper Willow Creek, Warm Spring in Marys Creek subbasin, and Warm Billy Spring and Rattlesnake Spring in Boulder Creek subbasin.

No populations have been found in the Maggie Creek subbasin, or the remaining portions of the cumulative assessment area. Surface waters associated with the upper Willow Creek, Warm Billy Spring, and Rattlesnake Spring would not likely be affected; however, the upper Antelope Creek and Warm Spring populations are located within an area predicted to potentially have surface water impacts. If substantial water level reductions occur in these springs, springsnail populations could be affected. If the springs were permanently dewatered, the springsnail populations in these springs would be lost.

The Goldstrike Mine also could contribute to flow reductions in upper Antelope Creek, which represents potential habitat for spotted frog. This project would not contribute to flow reductions at sites in the Maggie Creek drainage where spotted frog have been collected. Surface water impacts in upper Antelope Creek could range from a slight reduction in habitat quality to elimination of the spotted frog habitat within the affected area. Potential reduction in spotted frog numbers could contribute to a proposal to list this species.

## 5.7 Grazing Management

Portions of 16 grazing allotments are located in the cumulative assessment area, including the Squaw Valley, Tuscarora/Quarter Circle S, Twenty-five, Boulder Field, T Lazy S, Hadley, Carlin Canyon, Carlin Field, McKinley, Blue Basin, Lone Mountain, Adobe, Adobe Hills, Marys Mountain, Palisade, and Horseshoe allotments. For most of these allotments, public land provides 36 to 86 percent of the livestock carrying capacity. The Blue Basin, McKinley FFR, and Carlin Canyon allotments consist primarily of private lands with smaller parcels of public land.

Some of the water produced from Barrick's dewatering activities is used for irrigation and livestock watering in Boulder Valley. Water used to irrigate approximately 10,000 acres of land for the production of alfalfa, barley, and introduced pasture grasses and provide water to grazing livestock is conveyed via pipelines (Gralian 1998).

Range improvements within the cumulative assessment area include livestock water sources (e.g., improved springs, stock wells, stock ponds, water pipelines and troughs), fences, seeded rangeland, and cattle guards. A livestock exclusion fence has been constructed around the wetland area at Green, Knob, and Sand Dune springs in Boulder Valley to prevent grazing of approximately 1,000 acres of riparian vegetation. Water sources are critical to grazing operations since livestock require water daily and the location of these water sources directly affects the distribution of livestock within an allotment.

### 5.7.1 Mine Dewatering and Localized Water Management Activities

Ground water drawdown resulting from mine-related dewatering activities may affect various water sources used by livestock including improved springs, springs, seeps, and perennial stream reaches. Impacts are anticipated only for those water sources that are hydrologically connected with the regional ground water system. No impacts to water sources that obtain water from perched or localized aquifers are anticipated. Only stock ponds associated with seeps or springs connected to the regional ground water system potentially could be affected. Water troughs and pipelines associated with improved springs or stock wells also could be affected.

Impacts that may occur as a result of ground water drawdown include reduced flow or complete cessation of flow from water sources. The long-term loss of water sources would result in the reduction or loss of permitted active grazing use within a grazing allotment if alternative water sources are not present within the vicinity of the affected water sources or if lost water sources are not mitigated. In pastures where alternative water sources exist, the degree of impact on livestock distribution and stocking levels would depend on terrain, distance between water sources, timing of livestock use, and class of livestock. Drawdown impacts could be localized to water sources within one or several pastures within an allotment. The loss of the majority or all water sources within these pastures would likely affect livestock distribution, forage utilization, and grazing management operations.

Reductions in the number and distribution of water sources and reductions in permitted active grazing use would affect grazing permittees by forcing them to find additional rangeland for livestock or to reduce their herd size within the affected pasture or allotment to appropriate stocking levels as determined by the BLM. Permittees would likely try to find additional pasture to accommodate their grazing operations, otherwise the permittees would likely be subjected to economic losses if mitigation does not occur. Currently, all allotments and active permitted grazing use within the Elko District are adjudicated and the option of finding alternative rangeland for grazing is severely limited due to the limited amount of private land in the area.

Specific impacts to natural perennial water sources within the cumulative assessment area are described in Section 5.2.1.2. Some of the water-related range improvements in the Twenty-five, T Lazy S, Hadley, Carlin Field, McKinley, and Marys Mountain allotments potentially could be affected by ground water drawdown. Water-related range improvements in the Squaw Valley, Tuscarora/Quarter Circle S, Boulder Field, Carlin Canyon, Blue Basin, Lone Mountain, Adobe, Adobe Hills, Palisade, or Horseshoe allotments have a low probability of being affected by ground water drawdown.

#### 5.7.1.1 Twenty-five Allotment

Ten water-related range improvements, including six water troughs, one water pipeline, and three improved springs, potentially could be affected by cumulative ground water drawdown. Seven of the 10 improvements are located in the Willow Creek Seeding pasture, and the remaining improvements are located in the Santa Reina pasture. The potential long-term loss of all of the improvements in the Willow Creek Seeding pasture could result in the potential long-term loss of permitted active grazing use within the pasture. This pasture does not include any additional water sources such as perennial creeks or reservoirs. The potential long-term loss of improvements in the northern portion of the Santa Reina pasture may result in the long-term loss of permitted active grazing use or affect forage utilization. The northern portion of this pasture does not include perennial water sources. Perennial reaches of Squaw and North Antelope creeks would be alternative water sources for livestock in the southern portion of the pasture. A portion of Boulder Creek, located in the western portion of the Boulder Creek pasture, could potentially be affected by groundwater drawdown.

#### 5.7.1.2 T Lazy S Allotment

The majority of water-related range improvements and natural perennial water sources could be affected by cumulative ground water drawdown. Sixteen water-related range improvements, including four stockwater ponds, two water pipelines, three stock wells, and seven improved springs, could be affected by ground water drawdown. One water pipeline is located in the Betze-Post Pit area, which is closed to grazing. Fifteen improvements are located in the Central Native pasture and could be affected by ground water drawdown. The potential long-term loss of water sources could result in the long-term loss of permitted active grazing use within the pasture or affect forage utilization since additional water sources, such as perennial creeks or reservoirs, are not available for livestock.

Some seeps and springs within the Lower Northern Native, Upper Northern Native, Bob's Flat, and Lynn Creek seeding pastures also could be affected by cumulative ground water drawdown. Isolated seeps and springs in the higher elevations of the Tuscarora Mountains would likely be unaffected by ground water drawdown and would provide natural water sources for livestock in the central portion of the allotment.

#### 5.7.1.3 Hadley Allotment

Nine water-related range improvements, including five stock wells, two improved springs, one water pipeline, and one trough and pipeline, could be affected by cumulative ground water drawdown. All of these improvements are located in the South Hadley No. 2 pasture. If the water level were lowered beyond the well intake zone, or below the pump setting, the stock wells would no longer provide water for livestock use unless the pump setting or wells were deepened. The potential long-term loss of these water sources would result in the long-term loss of permitted active grazing use or affect forage utilization within the pasture. One improved spring and one stockwater pond would be available for livestock use in the South Hadley No. 2 pasture if the other water sources are not available. Alternative water sources, such as East Cottonwood Creek and Maggie Reservoir, may be available for livestock use. The perennial reach of East Cottonwood Creek could be reduced by ground water drawdown.

#### 5.7.1.4 Carlin Field Allotment

Three water-related range improvements, including one improved spring, one stock well, and one water pipeline, could be affected by cumulative ground water drawdown. The stock well is located in the North Carlin Field pasture, and an improved spring and a water pipeline are located in the South Carlin Field pasture. The stock well is located inside the area that could be affected by groundwater drawdown; therefore, the well may be affected as discussed previously for wells in the Hadley Allotment. Other water sources (i.e., improved springs, troughs, and a stock well) within the North Carlin Field pasture would be available for livestock use since they would not be affected by ground water drawdown. The potential long-term loss of an improved spring and a water pipeline within the Carlin Field South pasture would not likely affect the permitted active grazing use or forage utilization within the pasture. One improved spring would likely be unaffected by ground water drawdown and would likely provide an adequate supply of water within the small pasture.

#### 5.7.1.5 McKinley Allotment

Three water-related range improvements, including one stock well and two troughs, could be affected by cumulative ground water drawdown. All of these improvements are located in the South pasture. The potential long-term loss of this water source may result in the potential long-term loss of permitted active grazing use or affect forage utilization within the pasture.

#### 5.7.1.6 Marys Mountain Allotment

Seven water-related range improvements, including three improved springs, three water pipelines, and one natural spring, could be affected by cumulative ground water drawdown. The potential long-term loss of these water sources may result in the potential long-term loss of permitted active grazing use or affect forage utilization within the pasture. Additional water sources within the allotment, such as Marys and James creeks, may be available for livestock use.

### 5.7.2 Humboldt River

During the period of mine dewatering discharge, slightly increased water levels within the Humboldt River floodplain would likely increase the areal extent of herbaceous wetlands immediately adjacent to the river channel. Forage production and the carrying capacity of these narrow areas also would likely increase temporarily. Increased water levels also may increase the availability of water for livestock use. Discharge waters reaching the Humboldt and Carson sinks would not affect grazing management since livestock grazing is not allowed within these areas.

Although cumulative ground water drawdown may eventually reduce the Humboldt River baseflow after the mines' dewatering discharges cease, the mine-induced drawdown from the Goldstrike Mine is not predicted to contribute to the potential reduction in the river's baseflow.

### 5.7.3 Proposed Action and No Action Alternative

The maximum disturbance of 18 acres associated with the Proposed Action would have minimal impacts on grazing. Therefore, no cumulative grazing impacts are anticipated from the Proposed Action or the No Action Alternative.

## 5.8 Socioeconomics

This section provides a qualitative evaluation of potential cumulative effects to socioeconomics from existing and proposed mines within the study area. Because of the complex interrelationships of surface and ground water variables, and soil composition, geologic, climatological, and geochemical variables, all of which are influential on hydrologic impacts, it is not possible, with any degree of certainty, to identify the extent to which social and economic impacts may occur. However, more than 50 mitigation measures have been proposed by

Barrick and Newmont as part of their plans of operations. These mitigation measures, discussed on pages 1-9 through 1-12 of the CIA report (BLM 2000b), have been designed to mitigate environmental and economic impacts that may occur. It is, therefore, not expected that any economic losses will be sustained. Potential economic impacts have been identified and are addressed as part of this analysis as follows:

- Effects on water users and water-dependent natural resources due to reduction in surface water quantity and ground water quantity and quality
- Impacts to irrigators as a result of increased flow in the Humboldt River during mine discharge, and decreased flow in the river after cessation of mine discharge
- Impacts to water users and water-dependent natural resources due to potential increases in flooding, erosion, and sedimentation associated with water management activities
- Effects on recreational opportunities due to changes to the hydrologic system; it is assumed that adverse and beneficial impacts on wildlife and fisheries may have socioeconomic impacts related to hunting and fishing opportunities

The affected environment associated with socioeconomic-related cumulative impacts includes the mine dewatering area in the Carlin Trend and the Humboldt River basin that would be affected by mine discharge and other activities that discharge and/or consume water.

The study area for mine dewatering encompasses the six designated ground water basins shown in Figure 1-6, including the city of Carlin and the communities of Palisade and Dunphy. Socioeconomic concerns in this area include lowered water levels in wells, reduced flow in springs (livestock and wildlife impacts), reduced streamflow (irrigation and livestock impacts), and development of sinkholes (possible damage to private property and/or natural resources).

The regional study area for the Humboldt River basin extends from the Carlin gage on the Humboldt River downstream to the Humboldt Sink (Figure 1-6). This area potentially could be affected by discharge and consumption of water due to mining and other activities (e.g., irrigation, municipal, industrial, and domestic uses). Socioeconomic conditions in this area related to water use, consumption, and discharge are considered for the cumulative analysis.

## 5.8.1 Mine Dewatering and Localized Water Management Activities

Potential socioeconomic impacts that may occur in the mine dewatering area resulting from drawdown of ground water in the Carlin Trend are described in this section. Effects on ground water resources are described in Section 3.2.

### 5.8.1.1 Lowered Water Levels in Wells

Potential socioeconomic impacts associated with lowering the water level in a given well may include: increased pumping costs due to increased pumping head; need to lower the pump in the well; purchasing a new pump; and drilling a new deeper well. Specific impacts to individual wells would depend on well location, completion, depth, yield, pump type and setting depth, and water pumping levels.

Socioeconomic impacts resulting from lowered ground water levels could affect a variety of water uses, including domestic, industrial, commercial, irrigation, and stock water. Sections 5.2.1.3 and 5.2.1.4 identifies the number of water rights by category of use and potential cumulative impacts to these rights. If stock water availability were reduced, permitted active grazing use (i.e., AUMs) within a grazing allotment could be reduced. Grazing permittees would likely try to find additional pasture; however, because grazing allotments are fully allocated in this area, permittees would likely reduce livestock numbers with a resultant loss in income and associated impacts on the local economy (see Section 5.7, Grazing Management).

### 5.8.1.2 Reduced Flow in Springs

As described in Section 5.2.1, cumulative dewatering activity could impact flow from springs hydraulically connected to the regional ground water system within the ground water drawdown area. Springs with reduced flow may affect some water sources for livestock and wildlife, resulting in socioeconomic impacts to affected livestock owners and the state's wildlife resources (e.g., big game, upland game birds. raptors, and fishery resources). Hunting and fishing opportunities could be reduced in some of the impacted areas. Species of special concern (terrestrial wildlife and aquatic life) that potentially could be affected, including the Lahontan cutthroat trout, may require additional resources by wildlife agencies to monitor and evaluate the status of these species. Springs that support domestic water supply to the city of Carlin (i.e., Carlin Cold Spring in the Marys Creek drainage) also could be affected by dewatering in the Carlin Trend. Newmont would replace the drinking water supply for the city of Carlin to offset any impacts to the Carlin Cold Spring from dewatering activities (SOAP Final EIS, Appendix A – Mitigation Plan; BLM 1993d). Therefore, there would be no measurable socioeconomic impact to the city of Carlin's water supply as a result of dewatering activities.

#### 5.8.1.3 Reduced Streamflow

Numerical model simulations used to predict changes in stream baseflow as a result of cumulative ground water drawdown show that streams in the vicinity of the Carlin Trend could decline in flow during and after cessation of mining (Figure 5-5), including Rock Creek, Boulder Creek, Maggie Creek, Marys Creek, and Susie Creek. The predicted reductions in baseflows in these streams and the baseflow predictions over time are described in Section 5.2.1. The maximum changes in flow rates are predicted to occur after cessation of dewatering and with the exception of lower Maggie Creek, to be followed by a gradual return to approximate premine conditions. Potential impacts to Humboldt River flow are discussed in Section 5.2.2.

Section 5.2.1.4 describes the surface water rights that have been identified within the potential cumulative ground water drawdown area (Figure 3-21 and Table 3-17), including the water rights that are for irrigation or livestock watering. Section 5.2.1.4 indicates that some of these surface water rights potentially could be affected by ground water drawdown; therefore, socioeconomic impacts could occur from reduced streamflow for these designated uses, including costs to replace irrigation and livestock watering sources.

#### 5.8.1.4 Geology and Minerals

Some areas of sinkhole development have occurred in the Carlin Trend area that may be attributed to mine dewatering. Sinkholes are most likely to occur in areas where carbonate rocks are at or near the ground surface. Areas potentially susceptible to sinkhole development have been delineated in the Carlin Trend study area (see Section 5.1). Most of these potential sinkhole development areas are located between the Goldstrike and Gold Quarry mines. If any sinkholes develop as a result of mine dewatering, no cumulative socioeconomic impacts are expected, unless damage to private property and/or natural resources, as identified in Section 5.1, would require some form of corrective action.

### 5.8.2 Humboldt River

This section describes potential socioeconomic impacts that may occur in the Humboldt River basin resulting from discharges of dewatering water to the Humboldt River from the Goldstrike, Gold Quarry, Leeville, and Lone Tree mines. Based on current and proposed mining, dewatering discharges would continue until 2006, during which time flow in the Humboldt River would increase over premine conditions. After cessation of dewatering discharges, flow in the river would decline below premine conditions but would gradually recover to near premine rates; this recovery period may extend for more than 100 years.

#### 5.8.2.1 Increased River Flow

Additional contributions to Humboldt River flows from mine dewatering discharges are discussed in Section 5.2.2. Since the Humboldt River is over-appropriated, the additional excess mine water would be a positive effect to water right holders in the basin. Storage of excess mine water in Rye Patch Reservoir could provide additional water for irrigation downstream of the reservoir. An additional 100 to 200 cfs in the

Humboldt River is equivalent to approximately 6,000 to 12,000 acre-feet per month, some of which would be available to downstream irrigators.

Higher flow in the river year-round during the period of mine dewatering also may cause increased erosion of the riverbed and banks. This erosion could encroach slightly on private property along the river. Any erosion that causes loss of land could affect current and future economic values of the land.

An additional socioeconomic impact of increased water in the Humboldt River may include limiting the ability to repair irrigation diversion structures during the low-flow periods. Irrigators typically repair these structures as needed when river flow has declined in the fall. The increased flow from mine discharges may cause more water to be in contact with the irrigation structures on a year-round basis and make it more difficult to perform the necessary repairs. If irrigation structures cannot be repaired during low-flow periods, the cost to access and repair the structures may increase.

#### 5.8.2.2 Reduced River Flow

Based on numerical model results, the maximum predicted cumulative reduction in baseflow of the Humboldt River would occur near the end of dewatering operations. The long-term decrease in Humboldt River base flow could extend for a period of more than 100 years. As described in Section 5.2.2, mine-induced drawdown from the Goldstrike Mine is not predicted to contribute to potential reductions in Humboldt River baseflows. Therefore, the Goldstrike Mine would not contribute to potential cumulative reductions in Humboldt River baseflows.

#### 5.8.2.3 Water Quality Impacts

As discussed in Section 5.2.2, mine discharges to the Humboldt River could increase loads and possibly concentrations of inorganic constituents in the river and Humboldt and Carson sinks. Economic conditions would not be affected by potential increased chemical loads to the Humboldt River and Humboldt Sink.

### 5.8.3 Proposed Action and No Action Alternative

No cumulative socioeconomic impacts are anticipated from implementation of the Proposed Action (buried pipeline) or the No Action Alternative.

## 5.9 Native American Religious Concerns

Past, present, and reasonably foreseeable dewatering and water management activities in the region may result in a cumulative impact to resources of importance to Native Americans. The need to consider these potential impacts is addressed in the Archaeological Resources Protection Act, the National Historic Preservation Act, the American Indian Religious Freedom Act, the Native American Graves Protection and Repatriation Act, and Executive Order 13007. BLM guidance is contained in the Native American Consultation Handbook (8160) and its supplement (8160-1).

The Elko Field office of the BLM initiated Native American consultation with regard to the cumulative dewatering assessment on October 1, 1998. BLM efforts to engage in consultation have been ongoing since that date. The consultation process was initiated with the Te-Moak Tribe, the Duck Valley Tribe, the Fort Hall Tribe, the Battle Mountain Band, the Elko Band, the Wells Band, the South Fork Band, the Western Shoshone Historic Preservation Society, and the Western Shoshone Defense Project. Letters were sent via certified mail to each tribe, band, and organization (see Appendix G of the CIA report [BLM 2000b]. Through the consultation process, the BLM requested information from the Western Shoshone about culturally important or sacred sites that may be impacted by mine dewatering within the predicted 10-foot drawdown area as depicted to the Native Americans during consultation (see Figure G-1 in Appendix G of the CIA report [BLM 2000b]).

Native Americans are concerned with the public distribution of information regarding the location and nature of many traditional places. Specific information provided to the BLM has been held as confidential. Given the sensitivity of this issue, the current analysis addresses types of resources rather than specific resources. The only exception is traditional cultural properties that are widely known and for which information is available in the public domain.

Consultation and research conducted as a part of this assessment resulted in the identification of general issues that require consideration as part of the cumulative impact assessment. Those general issues include the following:

- Potential impacts to elements of traditional lifeways that currently occur in the assessment area need to be assessed. In particular, impacts to plant and animal species that are the subject of resource procurement activities must be identified. The Western Shoshone expressed concern with the regional decline of sage grouse habitat.

- Water is life. In acknowledgement, the Western Shoshone have expressed concern regarding impacts that would affect surface waters such as springs (hot and cold) and streams. The quality of the water is also of concern to the Western Shoshone.

- Potential impacts to National Register eligible traditional cultural properties, known or presumed Native American grave sites, and places of historical significance to Native Americans must be assessed.

- Potential impacts that would limit the ability of the Western Shoshone to maintain traditional religious practices currently conducted in the assessment area must be assessed.

- Potential impacts to natural elements that may in turn cause changes in Western Shoshone cosmology must be assessed.

It is recognized that there is no single Western Shoshone viewpoint regarding these matters (Crum 1994). Rather, a diversity of perspectives exists. Information presented herein regarding impacts to issues of Native American concern represents a composite view drawn from cited resources.

### 5.9.1 Impacts to Plants

As identified in Section 5.3 of this document, there are an estimated 600 acres of riparian/wetland vegetation in areas where perennial waters could be impacted by ground water drawdown. An estimated 18 acres wetland vegetation associated with isolated springs and seeps also occur in areas where perennial waters could be impacted. Although located outside the maximum drawdown area, hydrologic modeling simulations indicate that baseflow along the lower reach of Rock Creek could decrease (see Figure 5-3); this reduction could result in the loss of some riparian vegetation currently present along this reach. Effects to riparian vegetation are predicted to reach their maximum intensity about 100 years postmining and to gradually lessen as the ground water system rebounds.

The Western Shoshone place a high degree of cultural value on plant resources. Comparisons of traditional and current plant use reveal substantial overlap. Most species used traditionally remain in use. Actions addressed by the cumulative impact analysis could result in the loss of plants that otherwise would have been available for use by Western Shoshone. Gathering practices important to the maintenance of Western Shoshone cultural traditions may be impacted. Changes in the structure of plant communities would cause disruption among spirit forces. The Western Shoshone believe that little men and plant spirits would likely leave the area, affecting the distribution and availability of other plant resources (Clemmer 1990).

### 5.9.2 Impacts to Animals

As noted in Section 5.4, a reduction in riparian and wetland vegetation would affect terrestrial wildlife dependent on those resources. Impacted riparian/wetland vegetation and surrounding areas would support a lower diversity and reduced number of riparian dependent wildlife species. Species that could be impacted include big game (mule deer and antelope) and upland game birds (sage grouse, mourning dove, and chukar). Raptors and songbirds could be affected, but to a lesser extent.

Animals are of particular importance to the Western Shoshone. Many species continue to be an important subsistence resource. Actions addressed by the cumulative impact analysis could impact the abundance and distribution of many animal species and their habitat. Depending on the availability of alternate habitat, some animals could be lost from the population. Of particular concern, the ongoing regional decline of sage grouse and their habitat could be exacerbated (see Section 5.6). Sage grouse are considered sacred, and the hunting of these birds is important to the maintenance of Western Shoshone cultural identity. The continued presence and availability of sage grouse, along with that of other animal species, is important to the maintenance of Western Shoshone cultural traditions.

Also, a loss or redistribution of wildlife species would cause the disruption of spirit forces present in the area. The Western Shoshone believe that little men and animal spirits would likely move or may leave the area, affecting the distribution and availability of other game (Clemmer 1990). This may impact hunting activities important to the maintenance of cultural traditions.

### 5.9.3 Impacts to Water

Since "water is life," the Western Shoshone express particular concern regarding any impacts that may occur to surface waters such as springs and streams. Mine dewatering has been ongoing in the study area for some time. Monitoring conducted to-date by Newmont and Barrick is summarized in Sections 3.2.3.1 and 4.1.1 of the CIA report (BLM 2000b). Current limits of ground water drawdown and mounding are shown in Figure 5-2. These data indicate that several springs have either dried up or exhibit a reduced flow, and that along one drainage (Brush Creek) the streamflow and vegetation have been impacted (Adrian Brown Consultants, Inc. 1997, 1999). Some of these impacts may be due to mine dewatering.

Ground water modeling predictions indicate that the extent of the cone of ground water drawdown associated with the proposed mining activities would increase over time. The maximum extent of the 10-foot drawdown is predicted to occur some 100 years postmining. The maximum drawdown area is divided into areas in which perennial waters could potentially be impacted, and areas where perennial waters are less likely to be impacted (see Figure 5-5). Beaver Creek, Little Beaver Creek, Coyote Creek, Little Jack Creek, Indian Creek, Cottonwood Creek, Lynn Creek, Simon Creek, Willow Creek, Rock Creek, Boulder Creek, Bell Creek, Brush Creek, Rodeo Creek, Upper Antelope Creek (and its tributaries), North Antelope Creek, Squaw Creek, Marys Creek, and Maggie Creek are listed as streams that could be affected. Selected creeks were analyzed to predict the maximum reduction in baseflows (see Figure 3-18 of the CIA report [BLM 2000b]). The model simulations indicate that if the drawdown cone expands to the west as predicted by the HCI model (HCI 1999a) baseflows along lower Rock Creek could be reduced. Also, some loss in flow could occur at the Carlin Springs (hot and cold). Noticeable change in the water balance are predicted to occur in the Boulder Flat and Maggie Creek hydrographic areas, and to a lesser extent in the Rock Creek hydrographic area. The Rock Creek water balance would recover by about 2061. Minor changes could occur in the Marys Creek and Susie Creek area, while no change is predicted in the Willow Creek area.

As discussed in Section 5.2.1.1, it is not possible to identify conclusively which perennial waters would or would not be impacted. Impacts to perennial waters are most likely to occur over only a portion of the maximum potential drawdown area. Areas where perennial waters may potentially be impacted by ground water drawdown are shown in Figure 5-5. Springs and seeps located in these areas could experience some reduction in flow.

Actions considered in the cumulative impact assessment would operate in compliance with provisions of the Clean Water Act. Any discharge would need to be permitted by the Nevada Bureau of Water Pollution Control. Section 5.2.2 of this document identifies potential cumulative impacts to water quality in the Humboldt Sink.

Water sources are of special importance to the Western Shoshone both for their resource and their spiritual value. The maintenance of plant and animal communities is dependent on the availability of water derived from stream, springs, and seeps. A reduction or loss of flow from streams, springs, and seeps would alter the distribution and disposition of spirit forces associated with water. Impacts to Rock Creek would be of particular concern. Maintaining a relationship with these forces is integral to the spiritual life of the Western Shoshone. A reduction or loss of these flows would cause a disruption among spirit forces. The Western Shoshone believe that water babies, little men, and spirits found in and around the impacted water sources would likely leave. This may have an impact on the maintenance of Western Shoshone cultural traditions.

### 5.9.4 Impacts to Traditional Cultural Properties, Grave Sites, and Historic Sites

During the consultation process, the Western Shoshone referenced the Tosawihi Quarry and Rock Creek traditional cultural properties, and stressed the importance of continued access to these properties in the maintenance of cultural and traditional beliefs. The Western Shoshone consider information about the location of elements associated with these properties to be confidential. Of particular concern to the Western Shoshone is the lower reach of Rock Creek (that portion located south of Antelope Creek) and springs in the general vicinity of the current Hollister Mine.

The Tosawihi Quarry Traditional Cultural Property is located within the maximum extent of the 10-foot drawdown that is predicted to occur. Perennial streams, springs, and seeps present in the immediate vicinity of the Tosawihi Quarry Traditional Cultural Property appear to have a low probability of being impacted by ground water drawdown. However, areas where perennial waters may be impacted are located near the Tosawihi Quarry. These include reaches of upper Antelope Creek and its tributaries, a few isolated springs in the Willow Creek area, and, most importantly, the lower portion of North Antelope Creek. Given their location near these potentially impacted areas, impacts to springs and seeps at the Tosawihi Quarry could occur. Any such impact would most likely occur as drawdown approached its maximum areal extent (100 years postmining).

The Rock Creek Traditional Cultural Property is located just outside the outermost extent of the predicted 10-foot drawdown. Perennial streams, springs, and seeps present in the immediate vicinity of the property appear to have a low probability of being impacted by ground water drawdown. However, based on cumulative model simulations, baseflows along portions of Rock Creek could be reduced (Figure 5-3). This could result in a concomitant reduction of riparian plant species. These impacts could occur along a portion of Rock Creek that is of greatest concern to the Western Shoshone. Such temporary impacts could occur as drawdown approached its maximum areal extent (100 years postmining).

Based on these data, it appears that some level of impact may occur to the Tosawihi Quarry and the Rock Creek traditional cultural properties. Physical impacts could take the form of reduced flows in area streams and springs, and the modification of plant and animal species dependent on those waters. These impacts could most likely occur as drawdown approached its maximum areal extent (100 years postmining). The Western Shoshone believe that spiritual impacts may occur due to the disruption of forces associated with those waters, plants, and animals and that such impacts, either physical or spiritual, could affect the ability of Western Shoshone to maintain religious, cultural, and educational traditions.

### 5.9.5 Impacts to Traditional Religious Practices and Cosmology

Spirits can be benevolent or malevolent, depending on how they are treated. Many Western Shoshone rituals are directed at controlling the use of power and balancing the potentially dangerous spiritual powers that pervade nature. Western Shoshone religion is focused on maintaining the integrity of power spots, maintaining the presence of little men, maintaining their relationship with the owner-spirits of plants and animals, and maintaining life-giving forces such as the sun, earth, and water. Correcting neglected or abused relationships between humans and spirits is a major aspect of Western Shoshone religion.

This cumulative impact assessment documents the extent to which ground water drawdown may affect stream, spring, and seep flows in the assessment area. It also addresses the concomitant changes that may occur to vegetation patterns and wildlife distribution. Any such changes, individually and collectively, could impact the integrity of power spots, disrupt the flow of spiritual power (*Puha*), and cause the displacement of spirits (e.g., little men and water babies). Any such effects would have an impact on Western Shoshone spiritual life and cosmology, and may limit their potential to participate in traditional religious activities.

The Western Shoshone consider the modification of power relationships to be dangerous. Altering the intricate web of power relationships that occur over a landscape affects the basic relationship between the Western Shoshone and Mother Earth. The potential to balance malevolent powers that pervade nature becomes diminished. The very character of the spiritual realm would be modified. The potential for such an effect is of particular concern to the Western Shoshone because impacts associated with ground water drawdown would be so interwoven, and because the resultant disruption of spirit forces could occur over such a wide area.

The assessment of Native American concerns was based on two types of information. Initially, emphasis was placed on the review of existing literature. Sources reviewed included ethnographic reports and monographs that address the region and manuscripts and material on file with the BLM. The various bands of the Te-Moak Tribe of Western Shoshone, the Duck Valley Tribal Council, the Shoshone-Bannock Tribe, the Western Shoshone Defense Project, and the Western Shoshone Historic Preservation Society were contacted by the BLM.

Information derived from these sources indicates that ground water drawdown would have an effect on resources of specific concern to Native Americans. Water is central to all living and spiritual things. The Western Shoshone feel that predicted impacts to streamflows, springs, and seeps would have a particularly adverse effect. Impacts would occur to riparian communities and animals that depend on those communities. The Western Shoshone are very concerned with the direct impacts that would occur to water, plants, and animals. Of even greater concern to the Western Shoshone are the disruptions that would occur to life and spirit forces found in or associated with these waters, plants, and animals. Impacts would occur to two areas identified by BLM as traditional cultural properties. Impacts to those areas may affect the ability of the Western Shoshone to maintain cultural traditions.

In summary, the Western Shoshone believe that ground water drawdown would have an adverse impact on both the physical and spiritual worlds. Impacts of the magnitude proposed are dangerous in that they would substantially alter the intricate web of power relationships that exist in nature and between the Western Shoshone and Mother Earth. Native American consultation is still in progress, see Section 6.4.

## 5.10 Cultural Resources

Potential cumulative impacts to Native American religious concerns associated with the cumulative dewatering and water management operations are discussed in Section 5.9. No additional cumulative impacts to cultural resources are anticipated, including cumulative impacts associated with the Proposed Action or the No Action Alternative.

## 5.11 Air Quality

No cumulative air quality impacts are anticipated. No air quality impacts are anticipated from the cumulative dewatering and water management operations. As described in Section 4.1, the impacts associated with the Proposed Action (i.e., the buried pipeline) would be limited to short-term increases in particulates during the 2-week construction period. Therefore, no cumulative impacts are anticipated from the Proposed Action or the No Action Alternative.

## 5.12 Topography and Soils

No cumulative impacts to topography or soils are anticipated. No topography or soils impacts are anticipated from the cumulative dewatering and water management operations. As described in Section 4.2, the impacts associated with the Proposed Action would involve a short-term effect to a maximum of 18 acres of disturbance during pipeline construction; these impacts would cease following reclamation of the right-of-way. Therefore, no cumulative impacts to topography or soils are anticipated from the Proposed Action or the No Action Alternative.

## 5.13 Access and Land Use

No cumulative impacts to access and land use are anticipated. No access or land use impacts are anticipated from the cumulative dewatering and water management operations. As described in Section 4.8, the impacts associated with the Proposed Action would involve a short-term effect to a maximum of 18 acres of disturbance during pipeline construction; these impacts would cease following reclamation of the right-of-way. Therefore, no cumulative impacts to access or land use are anticipated from the Proposed Action or the No Action Alternative.

## 5.14 Visual Resources

No cumulative visual resource impacts are anticipated. No impacts to visual resources are anticipated from the cumulative dewatering and water management operations. As described in Section 4.10, the impacts associated with the Proposed Action would involve a short-term effect during pipeline construction; these impacts would cease following reclamation of the right-of-way. Therefore, no cumulative impacts to visual resources are anticipated from the Proposed Action or the No Action Alternative.

# 6.0 CONSULTATION AND COORDINATION

## 6.1 Introduction

Public participation specific to the Betze Project Supplemental EIS is summarized in this chapter. The summary indicates the means of public involvement, identifies persons and organizations to be contacted for comments, and specifies timeframes for accomplishing goals in accordance with 40 CFR 1506.6.

Public involvement in the Supplemental EIS process includes the necessary steps to identify and deal with public concerns and needs. The public involvement process assists in: (1) broadening the information base for decision making; (2) informing the public of the proposal and potential long-term impacts resulting from the action; and (3) ensuring that public needs and desires are understood by the BLM.

Opportunities for participation and public notices are required at four specific points in the EIS process: the scoping period, review of the Draft Supplemental EIS, review of the Final Supplemental EIS, and receipt of the Record of Decision.

- Scoping: The public is provided a 30-day scoping period to identify potential issues associated with the project that might warrant analysis during development of the Draft Supplemental EIS.
- Draft Supplemental EIS Review: The 60-day review is initiated by publication of a Notice of Availability for the Draft Supplemental EIS in the Federal Register. A public meeting will be held in Elko, Nevada, on September 26, 2000, to obtain comments.
- Final Supplemental EIS Review: The 30-day review is initiated by publication of a Notice of Availability for the Final Supplemental EIS in the Federal Register.
- Record of Decision: A Notice of Availability for the Record of Decision will be published in the Federal Register, and a news release will be issued.

## 6.2 Implementation

The items listed below outline the necessary components used to implement the public participation process.

1. Public Scoping Period and Meetings

The BLM published a Notice of Intent (NOI) to prepare the Supplemental EIS for Barrick's ground water pumping and water management operations in the Federal Register on August 31, 1994, and mailed a Dear Interested Party letter dated September 2, 1994, announcing the preparation of the Supplemental EIS to 465 people. Formal public scoping meetings were held in Elko, and Reno, Nevada on September 14 and 15, 1994, respectively. BLM received written comments from 11 individuals and groups, and 9 oral comments.

All appropriate news media and the public were notified of the periods available for comment.

Following receipt of Barrick's and ELLCO's application to amend the right-of-way for the proposed buried pipeline, the BLM published a second NOI in the Federal Register on January 7, 1998, and mailed a second Dear Interested Party letter dated January 14, 1998, to 284 people. A formal public scoping meeting was held in Elko, Nevada on February 5, 1998. In response to the second scoping notice, the BLM received six written comments.

2. EIS Mailing List

An EIS mailing list of interested persons was assembled from previous mining-related EIS mailing lists and is included at the end of this chapter. This list was supplemented during the scoping process and is continuously updated as needed throughout the EIS process.

3. Distribution of the Draft Supplemental EIS

The Draft Supplemental EIS will be distributed as follows:

- A Notice of Availability will be published in the Federal Register specifying the dates for the comment period and the dates, times, and locations of public hearings.

- A news release will be provided by the Elko District BLM at the beginning of the 60-day comment period. The news release will be submitted to all relevant news outlets.

- The Draft Supplemental EIS will be distributed to interested parties on the updated EIS mailing list.

- Letters received from interested parties concerning the Draft Supplemental EIS will be promptly acknowledged so respondents will know their comments have been received by BLM.

- A public meeting will be held in Elko to obtain comments on the Draft Supplemental EIS.

- Briefings will be offered for local and state government representatives and Congressional Representatives.

4. Distribution of the Final Supplemental EIS

The Final Supplemental EIS will be completed considering comments from the review of the Draft Supplemental EIS and released as follows:

- A Notice of Availability will be published in the Federal Register.

- Copies of the final document will be sent to those on the updated mailing list.

- A news release will be issued to all relevant news outlets through the Elko District BLM office.

5. Record of Decision

The Record of Decision will be distributed to people and organizations on the updated mailing list, and a Notice of Availability will be published in the Federal Register. A news release will be issued to all relevant news outlets to announce distribution of the Record of Decision.

## 6.3 Criteria and Methods by Which Public Input is Evaluated

Letters and other comments concerning the Draft Supplemental EIS will be reviewed and evaluated by the BLM to determine if substantive information is presented that requires a formal response, contains new data, or identifies deficiencies in the Draft Supplemental EIS. Steps would then be initiated to correct such deficiencies and to incorporate the relevant information into the Final Supplemental EIS.

## 6.4 Consultation with Others

The following state and Federal agencies were consulted during preparation of the EIS:

- Pershing County Water Conservation District

- Nevada Department of Conservation and Natural Resources
  - Division of Environmental Protection
  - Division of Water Resources
  - Division of Wildlife

- U.S. Natural Resources Conservation Service

- U.S. Army Corps of Engineers

- U.S. Fish and Wildlife Service

- U.S. Geological Survey, Water Resources Division

In addition, consultation is being conducted with the Te-Moak Tribe, the Duck Valley Tribe, the Fort Hall Tribe, the Battle Mountain Band, the Elko Band, the Wells Band, the South Fork Band, the Western Shoshone Historic Preservation Society, and the Western Shoshone Defense Project. To-date, Native American consultation efforts have mainly focused on information gathering. Future consultation efforts will include the following: (1) BLM will continue to seek more information on traditional cultural properties; (2) BLM will distribute information on the potential impacts of dewatering to the Western Shoshone community and its traditions, religion, and culture; (3) the BLM will discuss potential means of preventing or offsetting these impacts; (4) BLM will consult on the level of its consultation efforts, the impacts of dewatering, and the means of preventing or offsetting these impacts with the Nevada State Historic Preservation Office. Once the consultation process is complete, then the findings will be updated in the Final EIS.

## 6.5 Draft SEIS Review

A list of the agencies, organizations, and individuals on the BLM's mailing list to receive the Betze Project Draft Supplemental EIS is presented below.

**Federal Agencies**

Advisory Council on Historic Preservation - Washington, D.C.
Department of Health and Human Services, Centers for Disease Control - Atlanta, Georgia
Library of Congress, Exchange and Gift Division - Washington, D.C.
U.S. Air Force - Washington, D.C.
U.S. Air Force, Bolling Air Force Base – Washington, D.C.
U.S. Army Corps of Engineers - Reno, Nevada
U.S. Department of Commerce, National Weather Service - Elko, Nevada
U.S. Department of Energy - Washington, D.C.
U.S. Environmental Protection Agency - Las Vegas, Nevada
U.S. Environmental Protection Agency - Washington, D.C.
U.S. Environmental Protection Agency, Region IX - San Francisco, California
U.S. Fish & Wildlife Service - Boise, Idaho
U.S. Fish & Wildlife Service - Portland, Oregon
U.S. Fish & Wildlife Service - Reno, Nevada
U.S. Fish & Wildlife Service - Washington, D.C.
USDA Cooperative Extension Service, Great Basin College - Elko, Nevada
USDA Department of Commerce, National Weather Service - Elko, Nevada
USDA Forest Service, Humboldt – Toiyabe National Forest, Elko, Nevada
USDA Natural Resources Conservation Service – Elko, Nevada
USDA Natural Resources Conservation Service - Reno, Nevada
USDI - Washington, D.C.
USDI Bureau of Indian Affairs - Elko, Nevada
USDI Bureau of Indian Affairs - Washington, D.C.
USDI Bureau of Land Management - Washington, D.C.
USDI Bureau of Land Management, Battle Mountain Field Office - Battle Mountain, Nevada
USDI Bureau of Land Management, Carson City Field Office - Carson City, Nevada
USDI Bureau of Land Management, Ely Field Office - Ely, Nevada
USDI Bureau of Land Management, Las Vegas Field Office - Las Vegas, Nevada
USDI Bureau of Land Management, Nevada State Office - Reno, Nevada
USDI Bureau of Land Management, Winnemucca Field Office - Winnemucca, Nevada
USDI Bureau of Reclamation - Carson City, Nevada
USDI Bureau of Reclamation - Denver, Colorado
USDI Bureau of Reclamation - Sacramento, California
USDI Bureau of Reclamation - Washington, D.C.
USDI Minerals Management Service, Offshore Environmental Assessment Division - Washington, D.C.
USDI National Park Service - Washington, D.C.
USDI Natural Resources Library, Gifts and Exchange Section - Washington, D.C.
USDI Office of Environmental Policy and Compliance - Washington, D.C.

USDI Office of Public Affairs - Washington, D.C.
USDI, USGS, Environmental Affairs Program - Reston, Virginia

### State Agencies

Nevada Department of Transportation - Carson City, Nevada
Nevada Division of Environmental Protection, Bureau of Mining Regulations and Reclamation – Carson City, Nevada
Nevada Division of Forestry - Elko, Nevada
Nevada Division of Minerals - Carson City, Nevada
Nevada Division of Minerals - Las Vegas, Nevada
Nevada Division of State Lands - Carson City, Nevada
Nevada Division of Water Planning - Carson City, Nevada
Nevada Division of Water Resources - Elko, Nevada
Nevada Division of Wildlife - Elko, Nevada
Nevada Land Use Planning, Advisory Council - Carson City, Nevada
Nevada Legal Services - Carson City, Nevada
Nevada Natural Heritage Program - Carson City, Nevada
Nevada Office of Community Services - Carson City, Nevada
Nevada State Clearinghouse - Carson City, Nevada
Nevada State Historic Preservation Office - Carson City, Nevada
Nevada State Multiple Use Advisory Board - Carson City, Nevada
University of Nevada, Dept. of Mining Engineering, Mackay School of Mines - Reno, Nevada

### Local Agencies

Carlin Planning Board - Carlin, Nevada
Carlin, City of - Carlin, Nevada
Elko, City of - Elko, Nevada
Elko Chamber of Commerce - Elko, Nevada
Elko City Manager - Elko, Nevada
Carlin City Mayor - Carlin, Nevada
Elko City Mayor - Elko, Nevada
Elko City Planning Board - Elko, Nevada
Elko County Commissioners - Elko, Nevada
Elko County Conservation Assn. - Elko, Nevada
Elko County Manager - Elko, Nevada
Elko County School District - Elko, Nevada
Elko Public Land Use Planning Commission - Elko, Nevada
Eureka County Commissioners - Eureka, Nevada
Eureka County Public Land Advisory Commission - Eureka, Nevada
Great Basin College – Elko, Nevada
Lander County Board of Commissioners - Battle Mountain, Nevada
Lander County Commission - Austin, Nevada
Lander County Planning Commissioners - Battle Mountain, Nevada
NENDA – Elko, Nevada
Nevada Association of Counties - Carson City, Nevada
Pershing County Water Conservation District, Lovelock, Nevada
Pershing County Extension Agent - Lovelock, Nevada
Wells Administrator - Wells, Nevada
Wells Chamber of Commerce - Wells, Nevada
Wells, City of - Wells, Nevada

## Elected Officials

Dean Rhoads, Northern Nevada Senatorial District - Tuscarora, Nevada
Honorable C. Clifton Young - Reno, Nevada
Honorable Harry Reid, U.S. Senate - Carson City, Nevada
Honorable Jim Gibbons, U.S. House of Representatives - Reno, Nevada
Honorable Jim Gibbons, U.S. House of Representatives - Washington, D.C.
Honorable Kenny C. Guinn, Governor of the State of Nevada - Carson City, Nevada
Honorable Richard Bryan, U.S. Senate - Reno, Nevada
State Assemblyman John Carpenter, District 33 - Elko, Nevada
State Assemblyman John Marvel, District 34 - Battle Mountain, Nevada

## Local and State Libraries and Media

Elko County Library - Elko, Nevada
Elko Daily Free Press - Elko, Nevada
Eureka County Library - Eureka, Nevada
Getchell Library, University of Nevada - Reno, Nevada
Great Basin College Library - Elko, Nevada
Lander County Library - Battle Mountain, Nevada
Mine Regulations Reporter – Salt Lake City, Utah
Nevada State Library - Carson City, Nevada
North American Mining - Reno, Nevada
Salt Lake City Public Library - Salt Lake City, Utah
University of Nevada, Government Documents Library - Las Vegas, Nevada
University Of Nevada, James Dickenson Library - Las Vegas, Nevada
White Pine County Library - Ely, Nevada

## Tribal Organizations

Battle Mountain Band Council - Battle Mountain, Nevada
Battle Mountain Indian Colony - Battle Mountain, Nevada
Elko Band Council - Elko, Nevada
Elko Indian Colony - Elko, Nevada
Goshute Band Council - Ibapah, Utah
Native American Program, Citizen Alert - Reno, Nevada
Shoshone Paiute Tribal Council - Owyhee, Nevada
Southfork Band Council - Lee, Nevada
Te-Moak Tribe Of Western Shoshone - Elko, Nevada
Wells Band Council - Wells, Nevada
Western Shoshone Defense Project - Crescent Valley, Nevada
Western Shoshone Historic Preservation Society, Battle Mountain Indian Colony - Battle Mountain, Nevada
Western Shoshone Historic Preservation Society - Elko, Nevada
Western Shoshone Historic Preservation Society - Harrisonburg, Virginia
Western Shoshone Historic Preservation Society - New York, New York
Western Shoshone Historic Preservation Society - Pittsburgh, Pennsylvania
Western Shoshone Historic Preservation Society Executive Board of Trustees,
    Battle Mountain Indian Colony - Battle Mountain, Nevada
Western Shoshone Historic Preservation Society Executive Board of Trustees,
    Elko Indian Colony- Elko, Nevada
Western Shoshone Historic Preservation Society Executive Board of Trustees,
    Odgar's Indian Ranch - Ely, Nevada
Yomba Tribe - Austin, Nevada

## Organizations

Citizens for Mining - Boise, Idaho
Institute for Policy Research, Northwestern University, - Evanston, Illinois
Intermountain Water Alliance - Salt Lake City, Utah
Ironworkers Local 27 - Salt Lake City, Utah
Minerals Advisory Group, LLC - Tucson, Arizona
Mining Support Group - Elko, Nevada
National Mining Assoc. - Washington, D.C.
National Wildlife Federation - Portland, Oregon
Nevada Cattlemen's Association - Elko, Nevada
Nevada Farm Bureau - Sparks, Nevada
Nevada Mining Association - Reno, Nevada
Nevada Outdoor Recreation Association - Carson City, Nevada
Nevada Waterfowl Association - Reno, Nevada
Nevada Wildlife Federation - Reno, Nevada
Nevada Wildlife Society - Reno, Nevada
Nevada Woolgrowers Association - Elko, Nevada
Northeastern Nevada Miners & Prospectors - Elko, Nevada
Plumbers & Pipefitters - Sparks, Nevada
Public Resource Association - Reno, Nevada
Sierra Club - Elko, Nevada
Sierra Club, Toiyabe Chapter - Reno, Nevada
The Nature Conservancy of Nevada - Reno, Nevada
The Wilderness Society - San Francisco, California

## Businesses

26 Corporation - Battle Mountain, Nevada
26 Corporation - Elko, Nevada
Agri Beef Company - Tuscarora, Nevada
Arapahoe Resources - Salt Lake City, Utah
Barium Products & Mining Company - Reno, Nevada
Barnard Construction - Bozeman, Montana
Baroid Drilling Fluids, Inc. - Battle Mountain, Nevada
Baroid Drilling Fluids, Inc. - Potosi, Missouri
Barrick Goldstrike Mines Inc. - Elko, Nevada
Bullion Monarch - Provo, Utah
Caribou Inc. - Jerome, Idaho
Cimbar Performance Minerals/Baroid Drilling Fluids Inc - Cartersville, Georgia
Cortez Gold Mines - Beowawe, Nevada
Cyprus Metals Company - Sparks, Nevada
Dee Gold Mine Company - Valmy, Nevada
Elko Land & Livestock Company - Battle Mountain, Nevada
Endeavour Capital - Portland, Oregon
Exponent - Boulder, Colorado
FMC Gold Co. - Reno, Nevada
Franco-NV Mining Corp. - Reno, Nevada
Glamis Gold, Ltd - Valmy, Nevada
Great Basin Gold, Inc. - Battle Mountain, Nevada
Harland Bartholomeew & Assoc. - Sacramento, California
High Desert Mineral Resources, Inc - Elko, Nevada
High Desert of Nevada - Elko, Nevada

Homestake Mining Company - San Francisco, California
Hunter Dickinson, Inc - Vancouver, British Columbia, Canada
Hydro-Search - Reno, Nevada
Independence Mining Company - Elko, Nevada
Legarza Exploration - Elko, Nevada
Lone Tree Mine - Valmy, Nevada
Maggie Creek Ranch, Inc. - Elko, Nevada
Meridian Gold, Inc. - Reno, Nevada
Minex Resources, Inc. - Riverton, Wyoming
Mountain States Engineering - Elko, Nevada
Newmont Gold Company - Denver, Colorado
Newmont Gold Company - Reno, Nevada
Newmont Gold Company - Valmy, Nevada
Palisade Ranch, Inc. - Carlin, Nevada
Parsons Behle & Latimer - Salt Lake City, Utah
Pittston Nevada Gold Company - Reno, Nevada
Quest International - Reno, Nevada
Rayrock Mines, Inc. - Valmy, Nevada
Royal Gold - Denver, Colorado
Sierra Exploration, Inc. - Reno, Nevada
Sierra Pacific Power Company - Elko, Nevada
Sierra Pacific Power Company - Reno, Nevada
SWCA Inc. - Salt Lake City, Utah
TIC - Carson City, Nevada
Trend Gold Mines Inc. - Battle Mountain, Nevada
Tri Quest Resources - Vidalia, Louisiana
Trio Gold Corp. - Reno, Nevada
TS Joint Venture - Battle Mountain, Nevada
Uranerz U.S.A. Inc. - Reno, Nevada
Ward & Smith, P.A. - New Bern, North Carolina
West Gold Limited - Golden, Colorado
York Snow, Inc. - Salt Lake City, Utah

**Individuals**

Gary Arnold - Boothbay Harbor., Maine
John Barss - Prescott, Arizona
John Behrens – Barstow, California
Keith Bettles - Elko, Nevada
Charles Bispo - Carlin, Nevada
Julia Bosma-Douglas - Englewood, Colorado
Richard Bovee - Elko, Nevada
Jack Boyd - Halleck, Nevada
George Brown - Mead, Washington
John C. Behrens - Barstow, California
Myrtle Colthorn - Salt Lake City, Utah
Denise Connow - Elko, Nevada
Dick Coxon - Elko, Nevada
Justus Deen - Lamoille, Nevada
Drury & Frances Thiercof - Carlin, Nevada
Mark Dubois - Elko, Nevada
Richard Eckert, Jr. - Incline Village, Nevada
Trevor Elenbaas - Shawnee, Kansas
Tom Enos - Carlin, Nevada

John Geddie - Albuquerque, New Mexico
Rich Haddock - Reno, Nevada
Donald Harris - Elko, Nevada
Tom Healey - Vancouver, British Columbia, Canada
Scott Herr - Elko, Nevada
Chris Herres - Elko, Nevada
Steve Hoerger - Lakewood, Colorado
Lee Hoffman - Elko, Nevada
John Hogg - Elko, Nevada
Tom Holcomb - Elko, Nevada
Carrol Howell - Salt Lake City, Utah
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Margie Lane - Carlin, Nevada
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Meg Macdonald - Reno, Nevada
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Richard D. Manning - Astoria, Oregon
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Jim Pond - Elko, Nevada
Larry Ravinkar - Carlin, Nevada
Bill Ray - Altus, Oklahoma
Mark Sanders - Elko, Nevada
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Tom Seestanovich - Carlin, Nevada
Chris Sewall - Crescent Valley, Nevada
Marjorie Sill – Reno, Nevada
Barr Smedley - Salt Lake City, Utah
Joe Stenger - Carlsbad, Nevada
Joe Sustacha, Jr & Son - Lamoille, Nevada
Alan Sweide - Elko, Nevada
Edward S. Syrjala - Centerville, Massachusetts
Lee Taylor - Carlin, Nevada
Trent Temple - Elko, Nevada
Bill Upton - Elko, Nevada
Randy Vance - Elko, Nevada
Jack & Irene Walther - Lamoille, Nevada
Todd White - Elko, Nevada
John Williams - Portland, Oregon
John Wise - El Segundo, California
Mark Wood - Elko, Nevada
James J. Wright - Tuscarora, Nevada
Jane Zimmerman - Elko, Nevada

# 7.0 LIST OF PREPARERS AND REVIEWERS

## Lead Agency - Bureau of Land Management

| | |
|---|---|
| Project Manager | Kirk Laird |
| Wilderness/Recreation/Visual Resources | Evelyn Treiman |
| Wildlife/T&E | Ken Wilkinson |
| Cultural/Native American Religious Concerns | Eric Dillingham |
| Hydrology | Roger Congdon |
| Water Rights | Carol Marchio |
| Groundwater Modeling | Tom Olsen |
| Fisheries/Riparian | Carol Evans |
| Land Use | Carolyn Spoon |
| Grazing/Vegetation | Donna Nyrehn |
| Geology | Deb McFarlane |
| NEPA Compliance | Marlene Braun |

## Cooperating Agencies

U.S. Fish and Wildlife Service
Nevada Division of Wildlife

## ENSR - Third-Party EIS Contractor

| | | |
|---|---|---|
| Project Manager | Sophie Sawyer<br>ENSR | BA Biology<br>M.Ed. Science Education<br>21 years experience |
| Assistant Project Manager | Valerie Randall<br>ENSR | BA Urban Studies<br>22 years experience |
| Water Resources, Geology | Patrick Plumley<br>ESA Consultants, Inc. | BS Geology<br>MS Geology<br>16 years experience |
| Watershed, Surface Water | James Burrell<br>Riverside Technology, inc. | BS Forest Management<br>MS Civil Engineering/ Hydraulics<br>18 years experience |
| Grazing Management, Vegetation | Jon Alstad<br>ENSR | BS Animal Science<br>MS Range Science<br>12 years experience |
| Fisheries, including Threatened, Endangered, Candidate, and Sensitive Species | Rollin Daggett<br>ENSR | BS Zoology<br>MS Aquatic Biology<br>25 years experience |
| Wildlife, including Threatened, | Lori Nielsen | BS Wildlife Ecology and |

| | | |
|---|---|---|
| Endangered, Candidate, and Sensitive Species | ENSR | Management<br>14 years experience |
| Water Quality | Bill Schenderlein<br>ESA Consultants, Inc. | BS Chemistry<br>MS Civil Engineering<br>8 years experience |
| Geochemistry | James Drever, Ph.D.<br>University of Wyoming | BA Chemistry<br>MA Chemistry<br>Ph.D. Geochemistry<br>32 years experience |
| Geology, AutoCad | Ana Vargo<br>ESA Consultants, Inc. | BA Geology<br>MS Geology<br>9 years experience |
| Groundwater Modeling | Eileen Poeter, Ph.D.<br>Colorado School of Mines | BS Geology<br>MS Engineering<br>Ph.D. Engineering Science<br>15 years experience |
| Cumulative Impact Analysis[1] | | |

[1] The report *Cumulative Impact Analysis of Dewatering and Water Management Operations for the Betze Project, South Operations Area Project Amendment, and Leeville Project* and the summary of this report in Chapter 5 of the SEIS was prepared by ENSR (lead), Maxim, and Greystone and their subcontractors. This report is on file at the BLM Field Office in Elko, Nevada.

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# GLOSSARY

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|---|---|
| Acre-feet | The volume of liquid or solid required to cover 1 acre to a depth of 1 foot, or 43,560 cubic feet; measure for volumes of water, reservoir rock, etc. |
| Alluvial | Pertaining to material or processes associated with transportation or deposition of soil and rock by flowing water (e.g., streams or rivers). |
| Alluvium | Unconsolidated or poorly consolidated gravel, sands, and clays deposited by streams and rivers on riverbeds, floodplains, and alluvial fans. |
| Anabranch | In general, a channel section separated from other channel sections by large islands or occasionally by large bars. At separate locales in the project region, the main course of the Humboldt River is paralleled by a number of smaller subsidiary channels that may convey flows during normal and higher flow conditions. An example of this can be seen in Whirlwind Valley upstream of the outfall. For lack of a better term, these were referred to as anabranches. |
| Anticline | A fold in the strata where it is convex upward and the older rocks are toward the center of the curvature. |
| Aquifer | Stratum or zone that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs |
| Aquitard | A low-permeability unit that can store ground water and also transmit it slowly from one aquifer to another |
| Argillization | The conversion process of minerals in the host rocks to clay minerals. |
| Artesian | Refers to ground water under sufficient hydrostatic head to rise above the aquifer containing it. |
| Bedrock | Any solid rock exposed at the surface or overlain by unconsolidated material |
| Cambrian | The span of time between 570 and 505 million years ago. |
| Carbonate | A compound containing the radical $CO_3$. A sediment formed of the carbonates of calcium, magnesium, and iron (e.g., limestone and dolomite). |

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| Cenozoic | The span of time between 66 million years ago to the present. |
| Chert | A mineral or a rock that is siliceous and contains the mineral chert (a fine-grained variety of quartz). |
| Clastic | A textural term for a sedimentary rock formed from particles (clasts) that were mechanically transported. |
| Cone of Depression | The depression of heads around a pumping well caused by the withdrawal of water |
| Confining Bed | A layer of rock having very low hydraulic conductivity that hampers the movement of water into and out of an aquifer |
| Conglomerate | A sedimentary rock, were a significant fraction of which is composed of rounded pebbles and boulders. |
| Cretaceous | The span of time between 144 and 66 million years ago. |
| Decarbonatization | The process whereby carbonate-rock minerals are dissolved by hydrothermal fluids. |
| Devonian | The span of time between 408 and 360 million years ago. |
| Dike | A tabular body of igneous rock that cuts across the structure of adjacent rocks or cuts massive rocks. |
| Dolomite | A mineral, Calcium magnesium carbonate ($CaMg(CO_3)_2$), or a rock composed largely of dolomite. |
| Dolomitization | The process that transforms limestone partly or wholly to dolomite by replacing the original calcium carbonate (calcite) with calcium magnesium carbonate (dolomite). |
| Drawdown | The lowering of the water level in a well as a result of withdrawal; the reduction in head at a point caused by the withdrawal of water from an aquifer |
| Ephemeral Stream | A stream or a portion of a stream that flows briefly in direct response to precipitation in the immediate vicinity or in response to snowmelt and whose channel is at all times above the local water table. |

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| Evapotranspiration | The portion of precipitation returned to the air through evaporation and plant transpiration. |
| Fault | A fracture in rock units along which there has been displacement. |
| Floodplain | The portion of a river valley, adjacent to the channel, that is built of sediments deposited during the present regiment of the stream and that is covered with water when the river overflows its banks at flood stages. |
| Fluvial | Pertaining to rivers |
| Greenstone | Altered basalt and gabbro. |
| Ground Water Table | The surface between the zone of saturation and the zone of aeration; that surface of a body of unconfined ground water at which the pressure is equal to that of the atmosphere |
| Holocene | The span of time between 10,000 years ago and the present. |
| Host Rock | A rock body or wall rock enclosing mineralization. |
| Hydraulic Conductivity | The capacity of a rock to transmit water. It is expressed as the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow. |
| Hydraulic Gradient | Change in head per unit of distance measured in the direction of the steepest change. |
| Hydraulic Head | The height of the free surface of a body of water above a given subsurface point. Water flows from high hydraulic head to low, and an increase in head difference between two points will cause an increase in flow. |
| Hydrostratigraphic Unit | Grouping of stratified, mainly sedimentary rocks that have similar ground water flow conditions. |
| Hydrothermal fluids | Fluids at high temperatures, generally 300° to 500° C. |
| Igneous | Rock or mineral that solidified from molten or partly molten magma; processes relating to or resulting from the formation of such rocks. |

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| Intermittent Stream | A stream that flows only during part of the year, is below the local water table for at least some part of the year, and obtains its flow from both surface runoff and ground water discharge. |
| Intrusive | An igneous rock that solidified below the surface |
| Jurassic | The span of time between 208 and 144 million years ago. |
| Karst | A type of topography formed by dissolving limestone, dolomite, or gypsum and forming solution cavities, sink holes, caves, and underground drainages. A karst aquifer is an aquifer in which flow of water is or can be appreciable through one or more of the following: joints, faults, bedding planes, and cavities – any or all of which have been enlarged by dissolution of bedrock. |
| Lacustrine | Pertaining to, produced by, or formed in a lake or lakes. |
| Limestone | A sedimentary rock composed principally of calcite. |
| Mafic | An igneous rock were the is composed mostly of the magnesian rock-forming silicates. |
| Mesozoic | The span of time between 245 and 66 million years ago. |
| Mineralization | The process by which a valuable mineral or minerals are introduced into a rock. |
| Miocene | The span of time between 23.7 and 5.3 million years ago. |
| Mississippian | The span of time between 360 and 320 million years ago. |
| Monzonite | A type of plutonic rock that contains equal amounts of orthoclase and plagioclase. |
| Normal Fault | A dip-slip fault in which the block above the fault has moved downward relative to the block below. |
| Ordovician | The span of time between 505 and 438 million years ago. |
| Orogeny | The process of forming mountains. |
| Paleozoic | The Span of time from the end of the Precambrian to the beginning of the Mesozoic, ranging from approximately 570 to 245 million years ago. |

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| Pennsylvanian | The span of time between 320 and 286 million years ago. |
| Perennial Stream | A stream or reach of stream that flows throughout the year. |
| Permeable | The property or capacity of a porous rock, sediment, or soil to transmit a liquid. |
| Permian | The span of time between 286 and 245 million years ago. |
| Piezometer | A nonpumping well that is used to measure the elevation of water table or potentiometric surface. |
| Playa | The flat floor of a closed basin in an arid region. It may be occupied by an intermittent lake that disappears from evaporation. |
| Pleistocene | The span of time between 1.6 million years and 10,000 years ago. |
| Pliocene | The span of time between 5.3 and 1.6 million years ago. |
| Pluton | Any body of igneous rock that formed below the surface |
| Point Bar | An area where sediment is generally deposited on the inside of stream channel bends. Where they occur, typically point bars are relatively small, low-lying features adjacent to the flow; portions frequently exposed to active flow conditions are usually unvegetated. |
| Porosity | The voids or openings in a rock. Porosity may be expressed quantitatively as the ratio of the volume of openings in a rock to the total volume of the rock. |
| Potentiometric Surface | A surface that represents the total head in an aquifer: that is, it represents the height above a datum plane at which the water level stands in tightly cased wells that penetrate the aquifer. |
| Precambrian | The span of time older than 570 million years. |
| Quaternary | The span of time between 1.6 million years to present. |
| Seismicity | The likelihood of an area being subject to earth quakes; the phenomenon of earth movements. |
| Shale | A very fine-grained sedimentary rock composed of clay and silt. |

| | |
|---|---|
| Silicification | The process by which silica is added to marine clastic and carbonate host rocks. |
| Sill | A horizontal tabular intrusion that has been emplaced parallel to bedding. |
| Sinuosity | The degree of winding or curving of a stream channel, measured as the ratio of the length along the channel between two points to the straight air length between the two points. |
| Specific Storage | The amount of water per unit volume of a saturated formation that is stored or expelled from storage owing to compressibility and pore water per unit change in head. It is a dimensionless quantity. Specific storage has dimensions of 1/L. |
| Storativity | The volume of water that a permeable unit will absorb or expel from storage per unit surface area |
| Stratigraphy | Form, arrangement, geographic distribution, chronologic succession, classification, and relationships of rock strata. |
| Tertiary | Span of time between 65 and 3 to 2 million years ago. |
| Thrust Fault | A reverse fault in which the dip of the fault plane is relatively shallow. |
| Traditional Cultural Property | A property central and historically rooted to the beliefs, customs, and practices of a living community. |
| Transmissivity | The rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It equals the hydraulic conductivity multiplied by the aquifer thickness |
| Tuff | A compacted deposit of volcanic ash and dust that may contain up to 50 percent sediments, such as sand or clay. |
| Uplift | A structurally high area in the earth's crust produced by upthrusting rocks. |
| Water Table | The level in the saturated zone at which the pressure is equal to the atmospheric pressure. |
| Weir | An overflow structure built across an open channel, usually to measure the rate of water flow. |

# INDEX

Access and Land Use 4-7, 5-39
Affected Environment 3-1, 3-3, 3-21, 4-1
Air Quality 4-1, 5-38
Aquatic Resources 3-188, 3-202, 3-215, 5-24, 5-28
Continuing Operations 1-10
Cultural Resources 4-8, 5-38
Cumulative Impacts 5-1
Dewatering 1-29, 3-82, 3-153, 3-158, 3-171, 3-193, 5-1, 5-4, 5-19, 5-22, 5-24, 5-29, 5-32
Environmental Consequences 3-14, 3-81, 3-153, 3-170, 3-193, 3-221, 4-1
Faulting and Seismicity 3-10
Geochemistry 3-21
Geology 3-3, 5-1
Grazing Management 3-218, 4-7, 5-29
Ground Water 3-27, 3-85, 5-4, 5-9
Ground Water Quality 3-45, 3-105
Humboldt River 1-23, 3-20, 3-57, 3-116, 3-154, 3-158, 3-176, 3-193, 3-227, 5-3, 5-13, 5-21, 5-23, 5-25, 5-31, 5-33
Infiltration 1-22, 1-25, 3-107
Injection 1-22, 1-25
Interrelated Projects 1-27
Irretrievable 3-20, 3-140, 3-157, 3-187, 3-195, 3-217, 3-227, 4-10
Irreversible 3-20, 3-140, 3-157, 3-187, 3-195, 3-217, 3-227, 4-10
Meikle Mine 1-15
Mitigation 1-27, 3-20, 3-136, 3-156, 3-187, 3-195, 3-216, 3-227, 4-9
Monitoring 1-24, 1-26, 3-20, 3-136, 3-156, 3-187, 3-195, 3-216, 3-227
Native American Religious Concerns 5-34
Pit Lake 3-110, 3-175
Pit Lake Water Quality Evaluation 3-110, 3-177
Proposed Action 1-34, 2-1, 5-3
Purpose and Need 1-2
Residual Impacts 3-20, 3-140, 3-158, 3-187, 3-195, 3-217, 3-227, 4-10
Riparian Vegetation 3-142, 3-147, 5-19
Scoping 1-3, 6-1
Socioeconomics 5-31
Surface Water 3-54, 3-77, 5-9
Surface Water Quality 3-54, 3-78
Terrestrial Wildlife 3-158, 3-210, 4-3, 5-22, 5-25
Threatened, Endangered, Candidate, and Sensitive Species 3-196, 4-6, 5-25
TS Ranch Reservoir 1-18
Topography and Soils 4-2, 5-38
Vegetation 3-151, 4-3

Visual Resources ............................................................ 4-9, 5-39
Water Quality Impacts ............................................................ 3-105, 3-128
Water Resources ............................................................ 3-21, 4-2, 5-3
Wetlands ............................................................ 3-147

# APPENDIX A

# WATER RIGHTS

## Table A-1
## Ground Water Rights, Application for Ground Water Rights, and Other Known Wells

| App[1] # | Map[2] # | Status Permit/ Certificate[3] | Certificate Number | Township | Range | Section | Subdivision | Use[4] | Diversion Rate (CFS) | Annual Duty (Acre-Feet)[5] | Owner | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basin 50 – Susie Creek Area | | | | | | | | | | | | |
| 36901 | 1 | RFP | | 33 N. | 52 E. | 12 | NE¼ SW¼ | IRD | 5.400 | N.S. | Jefferson, Thomas F. | Application Only |
| 36902 | 2 | RFP | | 33 N. | 52 E. | 13 | NW¼ SE¼ | IRD | 5.400 | N.S. | Jefferson, Dorothy | Application Only |
| 36993 | 3 | RFA | | 34 N. | 52 E. | 25 | NE¼ SW¼ | IRD | 5.400 | N.S. | Newman, Claude W. | Application Only |
| 36994 | 4 | RFP | | 33 N. | 52 E. | 12 | NW¼ NE¼ | IRD | 5.400 | N.S. | Johnson, Ernest W. | Application Only |
| 36995 | 5 | RFA | | 33 N. | 52 E. | 13 | NE¼ SW¼ | IRD | 5.400 | N.S. | Stoltman, Dorothy J. | Application Only |
| 36996 | 6 | RFA | | 34 N. | 52 E. | 36 | NE¼ SE¼ | IRD | 5.400 | N.S. | Boyer, David E. | Application Only |
| 36997 | 7 | RFA | | 34 N. | 52 E. | 24 | SW¼ SW¼ | IRD | 5.400 | N.S. | Kaiser, Joseph F. | Application Only |
| 36998 | 8 | RFP | | 33 N. | 53 E. | 8 | NW¼ SW¼ | IRD | 5.400 | N.S. | Johnson, Barbara L. | Application Only |
| 36999 | 9 | RFA | | 33 N. | 52 E. | 1 | SW¼ NE¼ | IRD | 5.400 | N.S. | Salley, Curtis R. | Application Only |
| 39438 | 10 | CER | 11400 | 34 N. | 52 E. | 15 | NE¼ NE¼ | STK | 0.026 | 18.82 | Maggie Creek Ranch, Inc. | |
| 43062 | 11 | CER | 13266 | 33 N. | 53 E. | 19 | SE¼ SW¼ | IND | 0.036 | 0.18 | Van Waters & Rogers, Inc. | |
| 43131 | 12 | CER | 13228 | 33 N. | 52 E. | 24 | SW¼ NE¼ | QM | 0.167 | 0.18 | Meta-Tantay, Inc. | |
| 43298 | 13 | CER | 12982 | 33 N. | 53 E. | 19 | SW¼ SE¼ | IND | 0.033 | 1.14 | E.I. Dupond Denemours | |
| 46662 | 14 | CER | 11855 | 34 N. | 52 E. | 21 | SW¼ NE¼ | STK | 0.009 | 6.51 | Maggie Creek Ranch, Inc | |
| 49309 | 15 | CER | 12146 | 35 N. | 53 E. | 15 | NE¼ SE¼ | STK | 0.016 | 11.21 | Maggie Creek Ranch, Inc | |
| 49310 | 16 | CER | 12966 | 35 N. | 53 E. | 22 | SW¼ NE¼ | STK | 0.010 | 11.21 | Maggie Creek Ranch, Inc | |
| 49316 | 17 | CER | 12151 | 34 N. | 53 E. | 25 | NW¼ SE¼ | STK | 0.022 | 13.75 | Maggie Creek Ranch, Inc | |
| 49317 | 18 | CER | 12968 | 34 N. | 53 E. | 30 | NW¼ NE¼ | STK | 0.009 | 6.51 | Maggie Creek Ranch, Inc | |
| 49637 | 19 | CER | 12675 | 33 N. | 52 E. | 25 | NW¼ NW¼ | IND | 0.031 | 0.71 | Thatcher Chemical Co. | |
| 51576 | 20 | CER | 13752 | 33 N. | 52 E. | 24 | NE¼ SW¼ | QM | 0.334 | 16.82 | Prisons Department - Nevada | |
| 52372 | 21 | CER | 13591 | 34 N. | 53 E. | 26 | SW¼ NW¼ | STK | 0.031 | 22.41 | Maggie Creek Ranch, Inc | |
| 53179 | 22 | CER | 13593 | 34 N. | 53 E. | 5 | SW¼ SW¼ | STK | 0.031 | 22.41 | Maggie Creek Ranch, Inc | |
| 56510 | 24 | CER | 14768 | 33 N. | 52 E. | 24 | NE¼ SW¼ | QM | 0.089 | 13.88 | Prisons Department - Nevada | |
| 58029 | 25 | CER | 14529 | 35 N. | 53 E. | 9 | NE¼ SW¼ | STK | 0.025 | 17.93 | Maggie Creek Ranch, Inc | |
| 58030 | 26 | CER | 14530 | 35 N. | 53 E. | 28 | NE¼ SE¼ | STK | 0.011 | 7.98 | Maggie Creek Ranch, Inc | |
| 59836 | 27 | PER | | 33 N. | 52 E. | 25 | NE¼ NW¼ | IND | 0.600 | 24.19 | P.S.F. Limited Liabilities Company | |
| 60045 | 28 | RFP | | 33 N. | 53 E. | 19 | SW¼ SE¼ | IND | 0.110 | 30.70 | E.I. Dupond Denemours | Application Only |
| 63609 | 29 | PER | | 33 N. | 52 E. | 25 | NW¼ NE¼ | IND | 0.020 | 1.14 | Continental Lime, Inc. | |
| 64120 | 116 | PER | | 33 N. | 53 E. | 20 | SE¼ NE¼ | QM | 0.490 | 18 | Board of Regents (on behalf of UNR) | |
| 64121 | 117 | PER | | 33 N. | 53 E. | 20 | NE¼ SE¼ | OTH | 1.500 | 302 | Board of Regents (on behalf of UNR) | |
| 64873 | 118 | APP | | 33 N. | 53 E. | 20 | SE¼ NE¼ | OTH | 1.000 | 202 | Board of Regents (on behalf of UNR) | Application Only |
| 65003 | 119 | APP | | 35 N. | 54 E. | 14 | NW¼ NW¼ | STK | 0.010 | N.S. | Lauglin, Catalina; Lauglin, Patrick | Application Only |
| Basin 51 – Maggie Creek Area | | | | | | | | | | | | |
| 18551 | 30 | CER | 5876 | 33 N. | 52 E. | 16 | NE¼ NE¼ | IRR | 5.000 | 1339.95 | Hadley, Robert H.; Newmont Gold Company | |
| 20227 | 31 | CER | 5706 | 33 N. | 52 E. | 26 | NW¼ NW¼ | IRR | 0.045 | 5.59 | Meierhoff, Randy & Carmelia | |

## Table A-1 (Continued)
## Ground Water Rights, Application for Ground Water Rights, and Other Known Wells

| App[1] # | Map[2] # | Status Permit/ Certificate[3] | Certificate Number | Township | Range | Section | Subdivision | Use[4] | Diversion Rate (CFS) | Annual Duty (Acre-Feet)[5] | Owner | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 22214 | 32 | CER | 7188 | 33 N. | 52 E. | 26 | NW¼ NW¼ | IRR | 0.011 | 7.20 | Meierhoff, Ralph J. | |
| 31273 | 120 | CER | 10672 | 33 N. | 52 E. | 4 | SW¼ SW¼ | IRR | 1.000 | 78.42 | Newmont Gold Company | |
| 39872 | 121 | CER | 11673 | 34 N. | 51 E. | 7 | LT01 (NE¼ NE¼) | STK | 0.031 | 22.41 | Elko Land and Livestock, Co. | |
| 39874 | 122 | CER | 11674 | 35 N. | 51 E. | 31 | SE¼ SE¼ | STK | 0.006 | 4.36 | Elko Land and Livestock, Co. | |
| 46041 | 123 | CER | 11926 | 35 N. | 51 E. | 27 | NE¼ NE¼ | STK | 0.009 | 6.51 | Elko Land and Livestock, Co. | |
| 46045 | 124 | CER | 11930 | 34 N. | 51 E. | 3 | LT02 (NW¼ NE¼) | STK | 0.009 | 6.51 | Elko Land and Livestock, Co. | |
| 46046 | 125 | CER | 11931 | 35 N. | 51 E. | 30 | NE¼ NE¼ | STK | 0.005 | 2.76 | Elko Land and Livestock, Co. | |
| 48256 | 33 | CER | 11577 | 33 N. | 52 E. | 15 | NE¼ SW¼ | IRR | 2.061 | 443.22 | Newmont Gold Company | |
| 49311 | 34 | CER | 12147 | 37 N. | 52 E. | 16 | SW¼ SE¼ | STK | 0.018 | 22.41 | Maggie Creek Ranch Inc. | |
| 49312 | 35 | CER | 12967 | 37 N. | 52 E. | 27 | SE¼ SW¼ | STK | 0.018 | 11.21 | Maggie Creek Ranch, Inc | |
| 49319 | 36 | CER | 12152 | 34 N. | 52 E. | 20 | NE¼ NW¼ | STK | 0.010 | 7.21 | Maggie Creek Ranch, Inc | |
| 51981 | 37 | PER | | 33 N. | 52 E. | 23 | SW¼ SW¼ | MUN | 2.000 | 735.57 | Carlin - City of | |
| 53269 | 38 | CER | 13727 | 37 N. | 51 E. | 36 | SE¼ NW¼ | STK | 0.031 | 22.41 | Maggie Creek Ranch Inc. | |
| 54522 | 23 | CER | 13919 | 33 N. | 52 E. | 26 | SW¼ NE¼ | COM | 0.056 | 0.03 | The Anschutz Marketing and Trans. | |
| 57020 | 39 | RFP | | 34 N. | 51 E. | 35 | NW¼ | REC | 5.000 | N.S. | Elko County | Application Only |
| 57021 | 40 | RFP | | 34 N. | 51 E. | 34 | NE¼ | REC | 5.000 | N.S. | Elko County | Application Only |
| 57022 | 41 | RFP | | 33 N. | 51 E. | 3 | NE¼ | REC | 5.000 | N.S. | Elko County | Application Only |
| 57023 | 42 | RFP | | 33 N. | 51 E. | 2 | NW¼ | REC | 20.000 | N.S. | Elko County | Application Only |
| 57024 | 43 | RFP | | 34 N. | 51 E. | 35 | NE¼ | REC | 5.000 | N.S. | Elko County | Application Only |
| 57025 | 44 | RFP | | 34 N. | 51 E. | 35 | SE¼ | REC | 10.000 | N.S. | Elko County | Application Only |
| 57026 | 45 | RFP | | 34 N. | 51 E. | 35 | SW¼ | REC | 40.000 | N.S. | Elko County | Application Only |
| 57027 | 46 | RFP | | 33 N. | 51 E. | 2 | NE¼ | REC | 5.000 | N.S. | Elko County | Application Only |
| 57028 | 47 | RFP | | 34 N. | 51 E. | 34 | SE¼ | REC | 15.000 | N.S. | Elko County | Application Only |
| 60768 | 126 | PER | | 35 N. | 51 E. | 25 | SW¼ NW¼ | STK | 0.063 | 45.25 | Newmont Gold Company | |
| 60769 | 127 | PER | | 35 N. | 51 E. | 12 | NW¼ SE¼ | STK | 0.063 | 45.25 | Newmont Gold Company | |
| 62012 | 49 | PER | | 34 N. | 51 E. | 11 | SE¼ SW¼ | STK | 0.007 | 5.07 | Maggie Creek Ranch, Inc | |
| 62013 | 50 | PER | | 35 N. | 52 E. | 30 | NE¼ SW¼ | STK | 0.007 | 5.07 | Maggie Creek Ranch, Inc | |
| 62014 | 51 | PER | | 35 N. | 52 E. | 18 | NW¼ | STK | 0.007 | 5.07 | Maggie Creek Ranch, Inc | |
| 62530 | 128 | PER | | 34 N. | 51 E. | 9 | NW¼ NW¼ | STK | 0.004 | 3.10 | Elko Land and Livestock, Co. | |
| 62531 | 129 | PER | | 35 N. | 51 E. | 29 | NW¼ SW¼ | STK | 0.004 | 3.10 | Elko Land and Livestock, Co. | |
| NP | 111 | | | 33 N. | 52 E. | 8 | | DOM | | | Callahan | No water right permit required or obtained for use |
| NP | 112 | | | 33 N. | 52 E. | 9 | NW¼ NW¼ | DOM | | | Crouse | No water right permit required or obtained for use |
| NP | 113 | | | 33 N. | 52 E. | 9 | NW¼ NW¼ | DOM | | | Whitlock Lot 1 Bock A | No water right permit required or obtained for use |
| NP | 114 | | | 33 N. | 52 E. | 10 | SW¼ SW¼ | STK | | | Hadley | No water right permit required or obtained for use |
| NP | 115 | | | 34 N. | 52 E. | 17 | NW¼ SE¼ | STK | | | Hadley | No water right permit required or obtained for use |

## Ground Water Rights, Application for Ground Water Rights, and Other Known Wells

| App[1] # | Map[2] # | Status Permit/ Certificate[3] | Certificate Number | Township | Range | Section | Subdivision | Use[4] | Diversion Rate (CFS) | Annual Duty (Acre-Feet)[5] | Owner | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basin 52 – Marys Creek Area | | | | | | | | | | | | |
| 30971 | 53 | CER | 10102 | 33 N. | 52 E. | 27 | SE¼ SE¼ | STK | 0.003 | 2.18 | Eklund, Jo Ann; Eklund, L.W. | |
| 30987 | 54 | CER | 10103 | 33 N. | 52 E. | 27 | SE¼ SE¼ | IRR | 0.280 | 41.20 | Eklund, Jo Ann; Eklund, L.W. | |
| 34410 | 55 | CER | 10868 | 33 N. | 52 E. | 34 | NE¼ NW¼ | IRR | 0.100 | 9.81 | Jones, Melvin R.; Jones, Rachel S. | |
| 35107 | 56 | CER | 12535 | 33 N. | 52 E. | 33 | NE¼ NE¼ | IRR | 0.897 | 101.91 | Jones, Melvin R.; Jones, Rachel S. | |
| 42982 | 57 | CER | 11266 | 33 N. | 52 E. | 33 | NE¼ SW¼ | STK | 0.015 | 10.87 | Barrows, Elmer; Cater, Diana J.; Cater, Franklin L.; Newmont Gold Company | |
| 43918 | 58 | RFA | | 33 N. | 52 E. | 33 | NE¼ SW¼ | OTH | 4.000 | N.S. | Barrows, Elmer; Newmont Gold Company | Application Only |
| 47027 | 59 | PER | | 33 N. | 52 E. | 27 | SW¼ SE¼ | ENV | 1.000 | 724.21 | Southern Pacific Transportation Co. | |
| 47028 | 60 | PER | | 33 N. | 52 E. | 27 | SW¼ SE¼ | ENV | 1.000 | 724.21 | Southern Pacific Transportation Co. | |
| 50436 | 61 | PER | | 33 N. | 52 E. | 27 | SE¼ SW¼ | MUN | 0.890 | 644.58 | Carlin - City of | |
| 52266 | 62 | PER | | 33 N. | 52 E. | 27 | NE¼ NW¼ | MUN | 0.560 | 405.58 | Carlin - City of | |
| 57712 | 48 | PER | | 33 N. | 52 E. | 27 | SE¼ SE¼ | MUN | 2.000 | 735.57 | Carlin - City of | |
| 58323E | 52 | PER | | 33 N. | 52 E. | 27 | SW¼ SE¼ | ENV | 0.446 | 322.96 | Southern Pacific Transportation Co. | |
| Basin 61 – Boulder Flat | | | | | | | | | | | | |
| 12487 | 130 | CER | 4872 | 33 N. | 48 E. | 25 | SE¼ SE¼ | IRR | 5.587 | 861.84 | Newmont Gold Company | |
| 16951 | 131 | CER | 5605 | 34 N. | 49 E. | 5 | NE¼ NW¼ | IRR | 3.500 | 681.92 | Elko Land and Livestock, Co. | |
| 16952 | 132 | CER | 5606 | 34 N. | 49 E. | 6 | NE¼ NE¼ | IRR | 3.500 | 592 | Elko Land and Livestock, Co. | |
| 17490 | 133 | CER | 6214 | 33 N. | 48 E. | 24 | NW¼ SW¼ | IRR | 5.998 | 1444.80 | Newmont Gold Company | |
| 21083 | 63 | CER | 7306 | 33 N. | 48 E. | 26 | NW¼ NE¼ | MM | 0.334 | 242.04 | Baroid Division; National Lead Co. | |
| 22976 | 134 | CER | 7620 | 32 N. | 45 E. | 1 | SE¼ SE¼ | IRR | 3.000 | 671.40 | The 25 Corporation | |
| 23881 | 135 | CER | 7642 | 35 N. | 50 E. | 22 | NW¼ NW¼ | STK | 0.045 | 5.10 | Newmont Gold Company | |
| 24682 | 136 | CER | 8622 | 32 N. | 45 E. | 2 | SE¼ SE¼ | IRR | 3.000 | 1200.00 | 25 Corporation, Inc. | |
| 25247 | 137 | CER | 8461 | 33 N. | 48 E. | 23 | NE¼ NE¼ | IRR | 3.686 | 760.50 | Newmont Gold Company | |
| 26873 | 138 | CER | 8659 | 35 N. | 50 E. | 20 | LT01 (NE¼ NE¼) | STK | 0.025 | 12.03 | Elko Land and Livestock, Co. | |
| 27956 | 139 | CER | 8972 | 35 N. | 49 E. | 28 | SW¼ NE¼ | STK | 0.008 | 3.93 | Elko Land and Livestock, Co. | |
| 27957 | 140 | CER | 8973 | 33 N. | 49 E. | 26 | SE¼ SW¼ | STK | 0.003 | 1.96 | Elko Land and Livestock, Co. | |
| 28197 | 64 | CER | 10722 | 36 N. | 50 E. | 30 | NW¼ SE¼ | MM | 0.140 | 96.83 | Polar Resources Company | |
| 28966 | 141 | CER | 10226 | 34 N. | 49 E. | 7 | SE¼ NE¼ | IRR | 0.600 | 291.55 | Elko Land and Livestock, Co. | |
| 28967 | 142 | CER | 10227 | 34 N. | 49 E. | 8 | SE¼ NW¼ | IRR | 5.106 | 1021.44 | Elko Land and Livestock, Co. | |
| 28969 | 143 | CER | 9282 | 36 N. | 50 E. | 30 | NW¼ SE¼ | STK | 0.009 | 6.72 | Elko Land and Livestock, Co. | |
| 29529 | 144 | CER | 10228 | 34 N. | 50 E. | 19 | LT04 (NW¼ NW¼) | STK | 0.012 | 17.93 | Elko Land and Livestock, Co. | |
| 29952 | 145 | CER | 10043 | 33 N. | 49 E. | 2 | SW¼ NW¼ | IRR | 5.124 | 2794.25 | Elko Land and Livestock, Co. | |
| 29953 | 146 | CER | 10044 | 33 N. | 49 E. | 3 | SE¼ NW¼ | IRR | 4.902 | 2673.19 | Elko Land and Livestock, Co. | |
| 30240 | 147 | CER | 10046 | 33 N. | 49 E. | 3 | SW¼ NW¼ | IRR | 4.233 | 2308.35 | Elko Land and Livestock, Co. | |

## Table A-1 (Continued)
## Ground Water Rights, Application for Ground Water Rights, and Other Known Wells

| App[1] # | Map[2] # | Status Permit/ Certificate[3] | Certificate Number | Township | Range | Section | Subdivision | Use[4] | Diversion Rate (CFS) | Annual Duty (Acre-Feet)[5] | Owner | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30241 | 148 | CER | 10047 | 33 N. | 49 E. | 1 | SW¼ NW¼ | IRR | 5.793 | 3159.06 | Elko Land and Livestock, Co. | |
| 30242 | 149 | CER | 10048 | 33 N. | 49 E. | 2 | SW¼ NE¼ | IRR | 5.347 | 2915.85 | Elko Land and Livestock, Co. | |
| 30253 | 150 | CER | 10229 | 34 N. | 49 E. | 7 | SE¼ NE¼ | IRR | 4.524 | 1017.88 | Elko Land and Livestock, Co. | |
| 30615 | 65 | CER | 10865 | 35 N. | 50 E. | 10 | SW¼ SE¼ | MM | 0.160 | 64.29 | Polar Resources Company | |
| 30849 | 151 | CER | 10057 | 33 N. | 49 E. | 1 | SW¼ SW¼ | IRR | 5.459 | 2976.93 | Elko Land and Livestock, Co. | |
| 31288 | 152 | PER | | 34 N. | 49 E. | 5 | NE¼ NW¼ | IRR | 6.000 | 2560.00 | Elko Land and Livestock, Co. | |
| 31289 | 153 | PER | | 34 N. | 49 E. | 6 | NE¼ NE¼ | IRR | 5.400 | 2560.00 | Elko Land and Livestock, Co. | |
| 34766 | 154 | PER | | 33 N. | 49 E. | 1 | SE¼ NW¼ | IRR | 3.790 | 2743.18 | Elko Land and Livestock, Co. | |
| 34767 | 155 | PER | | 33 N. | 49 E. | 2 | SW¼ SE¼ | IRR | 3.790 | 2742.80 | Elko Land and Livestock, Co. | |
| 34768 | 156 | PER | | 33 N. | 49 E. | 2 | SW¼ SW¼ | IRR | 3.790 | 2742.80 | Elko Land and Livestock, Co. | |
| 34769 | 157 | PER | | 33 N. | 49 E. | 3 | SW¼ SE¼ | IRR | 3.790 | 2742.80 | Elko Land and Livestock, Co. | |
| 34770 | 158 | PER | | 33 N. | 49 E. | 3 | SW¼ SW¼ | IRR | 3.790 | 20889.92 | Elko Land and Livestock, Co. | |
| 34771 | 159 | PER | | 33 N. | 49 E. | 11 | SW¼ NW¼ | IRR | 3.790 | 2742.80 | Elko Land and Livestock, Co. | |
| 34772 | 160 | PER | | 33 N. | 49 E. | 10 | SW¼ NE¼ | IRR | 3.790 | 2742.80 | Elko Land and Livestock, Co. | |
| 34773 | 161 | PER | | 33 N. | 49 E. | 10 | SW¼ NW¼ | IRR | 3.790 | 2742.80 | Elko Land and Livestock, Co. | |
| 36022 | 162 | PER | | 34 N. | 49 E. | 8 | SE¼ NE¼ | IRR | 2.870 | 2039.72 | Elko Land and Livestock, Co. | |
| 39871 | 163 | CER | 10875 | 33 N. | 49 E. | 8 | SW¼ SE¼ | STK | 0.031 | 22.41 | Elko Land and Livestock, Co. | |
| 39873 | 164 | CER | 10876 | 33 N. | 48 E. | 1 | SE¼ NW¼ | STK | 0.062 | 44.82 | Elko Land and Livestock, Co. | |
| 40859 | 66 | CER | 12278 | 32 N. | 49 E. | 22 | LT08 (NE¼ NE¼) | STK | 0.019 | 13.51 | BLM | |
| 43562 | 67 | CER | 11638 | 33 N. | 48 E. | 26 | NE¼ NE¼ | QM | 0.010 | 0.03 | Davis, Joanna; Davis, John N. | |
| 44882 | 68 | RFA | | 35 N. | 48 E. | 34 | SE¼ SE¼ | STK | 0.005 | 3.62 | BLM | Application Only |
| 45664 | 69 | CER | 12985 | 32 N. | 49 E. | 28 | NE¼ SW¼ | IRR | 4.460 | 2176.20 | Zeda Corporation | |
| 45665 | 70 | CER | 12986 | 32 N. | 49 E. | 28 | NW¼ SW¼ | IRR | 5.120 | 2498.20 | Zeda Corporation | |
| 45666 | 71 | CER | 12987 | 32 N. | 49 E. | 28 | NW¼ NE¼ | IRR | 5.400 | 2634.80 | Zeda Corporation | |
| 46042 | 165 | CER | 11927 | 35 N. | 49 E. | 23 | NE¼ NE¼ | STK | 0.009 | 6.51 | Elko Land and Livestock, Co. | |
| 46043 | 166 | CER | 11928 | 35 N. | 49 E. | 19 | SE¼ NE¼ | STK | 0.009 | 6.51 | Elko Land and Livestock, Co. | |
| 46044 | 167 | CER | 11929 | 34 N. | 50 E. | 10 | SE¼ NE¼ | STK | 0.013 | 9.42 | Elko Land and Livestock, Co. | |
| 46047 | 168 | CER | 11915 | 33 N. | 48 E. | 5 | LT04 (NW¼ NW¼) | STK | 0.011 | 7.95 | Elko Land and Livestock, Co. | |
| 46048 | 169 | CER | 11916 | 34 N. | 49 E. | 16 | NE¼ SE¼ | STK | 0.009 | 6.51 | Elko Land and Livestock, Co. | |
| 46049 | 170 | CER | 11917 | 34 N. | 49 E. | 30 | NE¼ NW¼ | STK | 0.016 | 11.57 | Elko Land and Livestock, Co. | |
| 46050 | 171 | CER | 11918 | 34 N. | 49 E. | 34 | SE¼ NW¼ | STK | 0.016 | 11.57 | Elko Land and Livestock, Co. | |
| 46051 | 172 | CER | 11919 | 34 N. | 49 E. | 2 | SE¼ NW¼ | STK | 0.009 | 6.51 | Elko Land and Livestock, Co. | |
| 46052 | 173 | CER | 11920 | 34 N. | 49 E. | 8 | NE¼ SE¼ | STK | 0.009 | 6.51 | Elko Land and Livestock, Co. | |
| 46053 | 174 | CER | 11921 | 34 N. | 49 E. | 4 | NW¼ SW¼ | STK | 0.009 | 6.51 | Elko Land and Livestock, Co. | |
| 46054 | 175 | CER | 11932 | 33 N. | 47 E. | 14 | SE¼ NE¼ | STK | 0.013 | 9.42 | Elko Land and Livestock, Co. | |
| 46055 | 176 | CER | 11933 | 33 N. | 47 E. | 10 | SW¼ SE¼ | STK | 0.013 | 9.42 | Elko Land and Livestock, Co. | |
| 46056 | 177 | CER | 11934 | 33 N. | 47 E. | 1 | NW¼ SW¼ | STK | 0.013 | 9.42 | Elko Land and Livestock, Co. | |
| 46057 | 178 | CER | 11935 | 33 N. | 47 E. | 17 | SW¼ SE¼ | STK | 0.013 | 9.42 | Elko Land and Livestock, Co. | |
| 46058 | 179 | CER | 11936 | 33 N. | 47 E. | 21 | SW¼ NE¼ | STK | 0.011 | 7.95 | Elko Land and Livestock, Co. | |
| 46059 | 180 | CER | 11937 | 33 N. | 47 E. | 27 | SE¼ NW¼ | STK | 0.011 | 7.95 | Elko Land and Livestock, Co. | |
| 46060 | 181 | CER | 11938 | 33 N. | 47 E. | 28 | NE¼ NW¼ | STK | 0.013 | 9.42 | Elko Land and Livestock, Co. | |

## Ground Water Rights, Application for Ground Water Rights, and Other Known Wells

| App[1] # | Map[2] # | Status Permit/ Certificate[3] | Certificate Number | Township | Range | Section | Subdivision | Use[4] | Diversion Rate (CFS) | Annual Duty (Acre-Feet)[5] | Owner | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 46061 | 182 | CER | 11939 | 33 N. | 47 E. | 29 | SW¼ NW¼ | STK | 0.016 | 11.57 | Elko Land and Livestock, Co. | |
| 46062 | 183 | CER | 11940 | 32 N. | 49 E. | 11 | NE¼ SE¼ | STK | 0.009 | 6.51 | Elko Land and Livestock, Co. | |
| 46063 | 184 | CER | 11941 | 34 N. | 48 E. | 1 | NE¼ SW¼ | STK | 0.013 | 9.42 | Elko Land and Livestock, Co. | |
| 46064 | 185 | CER | 11942 | 34 N. | 48 E. | 34 | SE¼ SE¼ | STK | 0.011 | 7.95 | Elko Land and Livestock, Co. | |
| 46065 | 186 | CER | 11943 | 35 N. | 48 E. | 34 | SE¼ SE¼ | STK | 0.013 | 9.42 | Elko Land and Livestock, Co. | |
| 46066 | 187 | CER | 11944 | 33 N. | 49 E. | 15 | NW¼ SW¼ | STK | 0.016 | 11.21 | Elko Land and Livestock, Co. | |
| 46067 | 188 | CER | 11945 | 34 N. | 48 E. | 21 | NW¼ NW¼ | STK | 0.011 | 7.95 | Elko Land and Livestock, Co. | |
| 46489 | 189 | PER | | 33 N. | 48 E. | 19 | SW¼ SE¼ | STK | 0.100 | 67.23 | Elko Land and Livestock, Co. | |
| 46490 | 190 | PER | | 33 N. | 47 E. | 24 | NW¼ SE¼ | STK | 0.100 | 67.23 | Elko Land and Livestock, Co. | |
| 47688 | 191 | CER | 12827 | 33 N. | 48 E. | 1 | SE¼ NW¼ | STK | 0.116 | 82.92 | Elko Land and Livestock, Co. | |
| 52941 | 192 | PER | | 35 N. | 48 E. | 36 | NE¼ SW¼ | IRR | 5.400 | 3909.44 | Elko Land and Livestock, Co. | |
| 52942 | 193 | PER | | 35 N. | 48 E. | 36 | NE¼ NW¼ | IRR | 5.400 | 3090.44 | Elko Land and Livestock, Co. | |
| 52943 | 194 | PER | | 35 N. | 48 E. | 25 | NE¼ SW¼ | IRR | 5.400 | 3909.44 | Elko Land and Livestock, Co. | |
| 52944 | 195 | PER | | 35 N. | 49 E. | 31 | NE¼ NE¼ | IRR | 5.400 | 3909.44 | Elko Land and Livestock, Co. | |
| 52945 | 196 | PER | | 35 N. | 48 E. | 25 | NE¼ NW¼ | IRR | 5.400 | 3909.44 | Elko Land and Livestock, Co. | |
| 52946 | 197 | PER | | 35 N. | 49 E. | 30 | NE¼ SE¼ | IRR | 5.400 | 3909.44 | Elko Land and Livestock, Co. | |
| 52947 | 198 | PER | | 35 N. | 49 E. | 30 | NE¼ NE¼ | IRR | 5.400 | 3909.44 | Elko Land and Livestock, Co. | |
| 52948 | 199 | PER | | 35 N. | 49 E. | 19 | NE¼ SE¼ | IRR | 5.400 | 3909.44 | Elko Land and Livestock, Co. | |
| 52949 | 200 | PER | | 35 N. | 49 E. | 29 | NE¼ SE¼ | IRR | 5.400 | 3909.44 | Elko Land and Livestock, Co. | |
| 52950 | 201 | PER | | 35 N. | 49 E. | 29 | NE¼ NE¼ | IRR | 5.400 | 3909.44 | Elko Land and Livestock, Co. | |
| 53715 | 72 | PER | | 36 N. | 49 E. | 3 | SE¼ SW¼ | MM | 1.000 | 645.44 | Cordex Exploration Co. | |
| 54497 | 73 | PER | | 33 N. | 45 E. | 35 | NE¼ SE¼ | IND | 1.000 | 389.92 | Coastal Chem Inc. | |
| 54520 | 74 | CER | 14782 | 33 N. | 45 E. | 27 | NE¼ SE¼ | IND | 0.347 | 1.75 | FMC Corporation | |
| 54568 | 202 | PER | | 34 N. | 48 E. | 2 | SW¼ NW¼ | STK | 0.062 | 8.96 | Elko Land and Livestock, Co. | |
| 54827 | 203 | PER | | 35 N. | 48 E. | 24 | NE¼ SE¼ | IRR | 5.400 | 2560.00 | Elko Land and Livestock, Co. | |
| 54828 | 204 | PER | | 35 N. | 48 E. | 25 | SW¼ SE¼ | IRR | 5.400 | 2560.00 | Elko Land and Livestock, Co. | |
| 54829 | 205 | PER | | 35 N. | 48 E. | 36 | SW¼ NW¼ | IRR | 2.530 | 1800.28 | Elko Land and Livestock, Co. | |
| 54830 | 206 | PER | | 34 N. | 48 E. | 1 | NE¼ NW¼ | IRR | 5.400 | 2560.00 | Elko Land and Livestock, Co. | |
| 54831 | 207 | PER | | 34 N. | 48 E. | 1 | NW¼ SW¼ | IRR | 5.400 | 2560.00 | Elko Land and Livestock, Co. | |
| 54832 | 208 | PER | | 34 N. | 48 E. | 2 | SW¼ SW¼ | IRR | 2.210 | 1599.97 | Elko Land and Livestock, Co. | |
| 54833 | 209 | PER | | 34 N. | 48 E. | 11 | NW¼ NE¼ | IRR | 2.210 | 1599.97 | Elko Land and Livestock, Co. | |
| 54834 | 210 | PER | | 34 N. | 48 E. | 11 | NE¼ SW¼ | IRR | 2.210 | 1599.97 | Elko Land and Livestock, Co. | |
| 54835 | 211 | PER | | 34 N. | 48 E. | 14 | NW¼ NW¼ | IRR | 2.210 | 7680.00 | Elko Land and Livestock, Co. | |
| 54836 | 212 | PER | | 34 N. | 48 E. | 15 | SW¼ SE¼ | IRR | 2.210 | 1599.97 | Elko Land and Livestock, Co. | |
| 54837 | 213 | PER | | 34 N. | 48 E. | 22 | NE¼ NW¼ | IRR | 2.210 | 1599.97 | Elko Land and Livestock, Co. | |
| 54838 | 214 | PER | | 34 N. | 48 E. | 12 | NW¼ SW¼ | IRR | 2.210 | 1599.97 | Elko Land and Livestock, Co. | |
| 54839 | 215 | PER | | 34 N. | 48 E. | 11 | SE¼ SE¼ | IRR | 2.210 | 1599.97 | Elko Land and Livestock, Co. | |
| 55625 | 75 | PER | | 33 N. | 45 E. | 35 | NE¼ NW¼ | IND | 0.200 | 3.93 | Sierra Chemical Company | |
| 56207 | 218 | RFA | | 34 N. | 49 E. | 5 | NE¼ NW¼ | IRR | 2.667 | N.S. | Elko Land and Livestock, Co. | Application Only |
| 56208 | 219 | RFA | | 34 N. | 48 E. | 23 | NW¼ NW¼ | IRR | 0.833 | N.S. | Elko Land and Livestock, Co. | Application Only |
| 56209 | 220 | RFA | | 34 N. | 48 E. | 23 | NW¼ NW¼ | IRR | 0.934 | N.S. | Elko Land and Livestock, Co. | Application Only |
| 56210 | 221 | RFA | | 34 N. | 49 E. | 5 | NE¼ NW¼ | IRR | 4.466 | N.S. | Elko Land and Livestock, Co. | Application Only |
| 56211 | 222 | RFA | | 34 N. | 49 E. | 6 | NE¼ NE¼ | IRR | 4.466 | N.S. | Elko Land and Livestock, Co. | Application Only |

## Table A-1 (Continued)
## Ground Water Rights, Application for Ground Water Rights, and Other Known Wells

| App[1] # | Map[2] # | Status Permit/ Certificate[3] | Certificate Number | Township | Range | Section | Subdivision | Use[4] | Diversion Rate (CFS) | Annual Duty (Acre-Feet)[5] | Owner | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 56212 | 223 | RFA | | 34 N. | 48 E. | 14 | NW¼ SE¼ | IRR | 0.934 | N.S. | Elko Land and Livestock, Co. | Application Only |
| 56213 | 224 | RFA | | 34 N. | 48 E. | 14 | NW¼ SE¼ | IRR | 0.350 | N.S. | Elko Land and Livestock, Co. | Application Only |
| 56214 | 225 | RFA | | 34 N. | 49 E. | 6 | NE¼ NE¼ | IRR | 3.150 | N.S. | Elko Land and Livestock, Co. | Application Only |
| 56429 | 226 | RFA | | 34 N. | 48 E. | 11 | SE¼ SE¼ | IRR | 1.110 | N.S. | Elko Land and Livestock, Co. | Application Only |
| 56430 | 227 | RFA | | 34 N. | 48 E. | 12 | NW¼ SW¼ | IRR | 1.110 | N.S. | Elko Land and Livestock, Co. | Application Only |
| 56431 | 228 | RFA | | 34 N. | 48 E. | 22 | NE¼ NW¼ | IRR | 1.110 | 4352.36 | Elko Land and Livestock, Co. | Application Only |
| 56432 | 229 | RFA | | 34 N. | 48 E. | 15 | SW¼ SE¼ | IRR | 1.110 | 4352.36 | Elko Land and Livestock, Co. | Application Only |
| 56433 | 230 | RFA | | 34 N. | 48 E. | 14 | NW¼ NW¼ | IRR | 1.110 | 4352.36 | Elko Land and Livestock, Co. | Application Only |
| 56434 | 231 | RFA | | 34 N. | 48 E. | 11 | NE¼ SW¼ | IRR | 1.110 | 4352.36 | Elko Land and Livestock, Co. | Application Only |
| 56435 | 232 | RFA | | 34 N. | 48 E. | 11 | NW¼ NE¼ | IRR | 1.110 | 4352.36 | Elko Land and Livestock, Co. | Application Only |
| 56436 | 233 | RFA | | 34 N. | 48 E. | 2 | SW¼ SW¼ | IRR | 1.110 | 4352.36 | Elko Land and Livestock, Co. | Application Only |
| 57755 | 76 | PER | | 36 N. | 49 E. | 4 | NE¼ NE¼ | MM | 1.000 | 645.20 | Dee Gold Mining Company | |
| 57756 | 77 | PER | | 36 N. | 49 E. | 3 | SE¼ SW¼ | MM | 1.000 | 645.20 | Dee Gold Mining Company | |
| 57757 | 78 | PER | | 36 N. | 49 E. | 4 | NE¼ NE¼ | MM | 1.000 | 645.20 | Dee Gold Mining Company | |
| 57758E | 85 | PER | | 36 N. | 49 E. | 10 | SE¼ SW¼ | ENV | 0.250 | 181.13 | Cordex Exploration Company | |
| 57759E | 86 | PER | | 36 N. | 49 E. | 10 | NE¼ SW¼ | ENV | 0.250 | 181.13 | Cordex Exploration Company | |
| 57788 | 87 | PER | | 36 N. | 49 E. | 28 | NW¼ NE¼ | STK | 0.031 | 22.41 | Packer, Willis; Rhoads, Dean A; Rhoads, Sharon | |
| 57789 | 79 | PER | | 35 N. | 49 E. | 18 | SW¼ NE¼ | STK | 0.031 | 22.41 | Packer, Willis; Rhoads, Dean A; Rhoads, Sharon | |
| 57882 | 80 | PER | | 36 N. | 49 E. | 3 | SW¼ SW¼ | MM | 1.000 | 645.20 | Dee Gold Mining Company | |
| 57883 | 81 | PER | | 36 N. | 49 E. | 3 | SW¼ SW¼ | MM | 1.000 | 645.20 | Cordex Exploration Co. | |
| 58254 | 82 | PER | | 36 N. | 49 E. | 2 | NE¼ NW¼ | MM | 2.000 | 1084.50 | Dee Gold Mining Company | |
| 59055 | 235 | CER | 14588 | 32 N. | 50 E. | 11 | NW¼ SE¼ | STK | 0.009 | 5.03 | Elko Land and Livestock, Co. | |
| 59060 | 236 | PER | | 33 N. | 48 E. | 25 | SE¼ SE¼ | OTH | 0.500 | 77.13 | Newmont Gold Company | |
| 59342 | 83 | PER | | 32 N. | 50 E. | 14 | NE¼ NE¼ | QM | 0.160 | 1.60 | Transportation Department-Nevada | |
| 62579 | 84 | PER | | 37 N. | 49 E. | 27 | SE¼ NE¼ | MM | 2.000 | 1448.00 | Meridian Gold Company | |
| 63002 | 237 | PER | | 33 N. | 49 E. | 32 | NW¼ NE¼ | STK | 0.003 | 1.96 | Elko Land and Livestock, Co. | |
| 64229 | 238 | RFP | | 35 N. | 49 E. | 3 | NE¼ NW¼ | STO | 78.000 | N.S. | Newmont Gold Company | Application Only |
| 64359 | 239 | RFA | | 32 N. | 49 E. | 5 | LT03 (NE¼ NW¼) | QM | 0.110 | N.S. | Transportation Department - Nevada | Application Only |
| V05780 | 88 | VST | | 32 N. | 45 E. | 15 | NW¼ NW¼ | STK | 0.025 | N.S. | Julian Tomera Ranches, Inc. | |
| V05782 | 89 | VST | | 32 N. | 45 E. | 9 | NW¼ NE¼ | STK | 0.025 | N.S. | Julian Tomera Ranches, Inc. | |
| Basin 62 – Rock Creek Valley | | | | | | | | | | | | |
| 42931 | 90 | PER | | 37 N. | 49 E. | 22 | NW¼ NE¼ | MM | 1.000 | 724.24 | Baroid Drilling Fluids Inc; FMC Minerals Corp. | |
| 42932 | 91 | PER | | 37 N. | 49 E. | 22 | NE¼ NE¼ | MM | 1.000 | 724.24 | Baroid Drilling Fluids Inc; FMC Minerals Corp. | |
| 42934 | 92 | PER | | 37 N. | 49 E. | 15 | NE¼ SE¼ | MM | 0.220 | 159.03 | Baroid Drilling Fluids Inc; FMC Minerals Corp. | |
| 44881 | 93 | CER | 12662 | 35 N. | 46 E. | 10 | SE¼ NW¼ | STK | 0.006 | 4.36 | BLM | |
| 44954 | 94 | CER | 12610 | 36 N. | 46 E. | 22 | NW¼ SW¼ | STK | 0.008 | 6.05 | BLM | |

| App[1] # | Map[2] # | Status Permit/ Certificate[3] | Certificate Number | Township | Range | Section | Subdivision | Use[4] | Diversion Rate (CFS) | Annual Duty (Acre-Feet)[5] | Owner | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 52750 | 95 | CER | 14005 | 37 N. | 48 E. | 8 | NE¼ NE¼ | MM | 0.116 | 33.03 | Newmont Exploration, LTD.; Touchstone Resources Co. | |
| 52751 | 96 | CER | 14006 | 37 N. | 48 E. | 9 | NE¼ NW¼ | MM | 0.223 | 51.15 | Newmont Exploration, LTD.; Touchstone Resources Co. | |
| 52752 | 97 | PER | | 37 N. | 48 E. | 9 | SE¼ NW¼ | MM | 0.400 | 289.81 | Newmont Exploration, LTD.; Touchstone Resources Co. | |
| 52754 | 98 | PER | | 37 N. | 48 E. | 9 | SW¼ SW¼ | MM | 0.500 | 362.26 | Newmont Exploration, LTD.; Touchstone Resources Co. | |
| 59063 | 99 | CER | 14938 | 35 N. | 48 E. | 11 | SE¼ NW¼ | STK | 0.018 | 12.89 | Packer, Willis; Rhoads, Dean A; Rhoads, Sharon | |
| 61410 | 100 | PER | | 37 N. | 49 E. | 22 | SE¼ SW¼ | MM | 0.780 | 565.00 | Baroid Drilling Fluids, Inc. | |
| 62577 | 101 | PER | | 37 N. | 49 E. | 16 | SW¼ SW¼ | MM | 2.000 | 1448.00 | Meridian Gold Company | |
| 62578 | 102 | PER | | 37 N. | 49 E. | 22 | NE¼ SW¼ | MM | 2.000 | 1448.00 | Meridian Gold Company | |
| Basin 63 – Willow Creek Valley | | | | | | | | | | | | |
| 44946 | 103 | CER | 12271 | 38 N. | 46 E. | 33 | NW¼ NW¼ | STK | 0.010 | 7.25 | BLM | |
| 45107 | 240 | CER | 10777 | 38 N. | 47 E. | 5 | NW¼ NE¼ | IRR | 4.650 | 3365.67 | Barrick Goldstrike Mines, Inc. | |
| 46559 | 241 | CER | 10779 | 38 N. | 46 E. | 2 | SW¼ NW¼ | IRR | 2.160 | 1563.40 | Barrick Goldstrike Mines, Inc. | |
| 48243 | 242 | CER | 11576 | 38 N. | 46 E. | 33 | NW¼ NW¼ | STK | 0.007 | 5.07 | Barrick Goldstrike Mines, Inc. | |
| 58714 | 104 | PER | | 39 N. | 46 E. | 17 | SE¼ SE¼ | QM | 0.100 | 40.00 | Midas Water Cooperative | |
| 60669 | 105 | PER | | 39 N. | 46 E. | 34 | NE¼ SE¼ | MM | 0.250 | 5.00 | Midas Joint Venture | |
| 61888 | 106 | PER | | 39 N. | 46 E. | 22 | NW¼ NW¼ | MM | 0.250 | 4.50 | Midas Joint Venture | |
| 62114 | 107 | PER | | 39 N. | 46 E. | 21 | NE¼ NW¼ | MM | 0.018 | 0.30 | Midas Joint Venture | |
| 62582 | 108 | PER | | 39 N. | 46 E. | 27 | NW¼ NW¼ | MM | 0.545 | 59.95 | Midas Joint Venture | |
| 63022 | 109 | PER | | 39 N. | 46 E. | 27 | NW¼ NE¼ | MM | 0.056 | 40.51 | Midas Joint Venture | |
| 64391 | 243 | RFA | | 39 N. | 46 E. | 21 | NW¼ NE¼ | MM | 0.150 | N.S. | Romarco Nevada, Inc. | Application Only |
| 64392 | 244 | RFA | | 39 N. | 46 E. | 21 | NW¼ SE¼ | MM | 0.150 | N.S. | Romarco Nevada, Inc. | Application Only |
| 64598 | 245 | RFA | | 39 N. | 46 E. | 22 | NW¼ NW¼ | MM | 0.250 | N.S. | Midas Joint Venture | Application Only |
| 64802T | 246 | PER | | 39 N. | 46 E. | 27 | NW¼ SW¼ | MM | 0.545 | 59.95 | Midas Joint Venture | |
| 64803 | 247 | RFA | | 39 N. | 46 E. | 27 | NW¼ SW¼ | MM | 0.545 | N.S. | Midas Joint Venture | Application Only |
| V04120 | 110 | VST | | 39 N. | 46 E. | 17 | NE¼ SW¼ | QM | 0.084 | N.S. | The Midas Water Cooperative | |

[1] NP = No water right permit required or obtained for use

[2] Refer to Figure 3.2-8.

[3] Status:
- APP - Application
- CER - Certificate
- PER - Permit
- RFA - Ready for Action
- RFP - Ready for Action (protested)
- VST - Vested Right

[4] Use:
- COM - Commercial
- DOM - Domestic
- ENV - Environmental
- IND - Industrial
- IRD - Irrigation (DLE)
- IRR - Irrigation
- MM - Mining and Milling
- MUN - Municipal
- OTH - Other
- QM - Quasi-municipal
- REC - Recreation
- STK - Stock Watering
- STO - Storage

[5] Annual Duty – Annual or Seasonal Amounts
N.S. – Not Specified

# Table A-2
## Surface Water Rights and Application for Surface Water Rights

| App # | Map[1] # | Status Permit/ Certificate[2] | Certificate Number | Township | Range | Section | Subdivision | Use[3] | Diversion Rate (CFS) | Annual Duty (Acre-Feet)[4] | Owner | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basin 50 – Susie Creek Area | | | | | | | | | | | | |
| 46542 | 1 | RFA | | 35 N. | 54 E. | 19 | NE¼ SE¼ | STK | 0.100 | N.S. | Dressi Ranching Company | Application Only |
| 54712 | 2 | PER | | 34 N. | 53 E. | 16 | NW¼ NW¼ | STK | 0.031 | 22.4 | Maggie Creek Ranch Inc. | |
| 56340 | 3 | RFA | | 33 N. | 53 E. | 7 | LT01 (NE¼ NE¼) | STK | 0.015 | N.S. | Maggie Creek Ranch Inc. | Application Only |
| 56557 | 4 | RFA | | 34 N. | 53 E. | 16 | NW¼ NW¼ | STK | 0.031 | N.S. | Maggie Creek Ranch Inc. | Application Only |
| R05315 | 5 | RES | | 35 N. | 54 E. | 12 | SW¼ SW¼ | OTH | 0.012 | N.S. | BLM | |
| Basin 51 – Maggie Creek Area | | | | | | | | | | | | |
| 00322 | | PRO | | | | | | DEC | | 96 | Elko Land and Livestock/JW Pruett [5] | Dispersed Points of Diversion, not illustrated [6] |
| 00325 | | PRO | | | | | | DEC | | N.S. | Roy Ash/Charles Thorton [5] | Dispersed Points of Diversion, not illustrated [6] |
| 00326 | | PRO | | | | | | DEC | | N.S. | Roy Ash/Charles Thorton [5] | Dispersed Points of Diversion, not illustrated [6] |
| 00327 | | PRO | | | | | | DEC | | 906.5 [7] | Roy Ash/Charles Thorton [5] | Dispersed Points of Diversion, not illustrated [6] |
| 00328 | | PRO | | | | | | DEC | | N.S. | Roy Ash/Charles Thorton [5] | Dispersed Points of Diversion, not illustrated [6] |
| 00329 | | PRO | | | | | | DEC | | N.S. | Roy Ash/Charles Thorton [5] | Dispersed Points of Diversion, not illustrated [6] |
| 2286 | 6 | CER | 346 | 33 N. | 52 E. | 26 | SW¼ SE¼ | OTH | 7.570 | 150.0 | Nevada Land & Resource Company, LLC; Vogeler, A.H.; Vogeler, Mary B. | |
| 2473 | 7 | CER | 11156 | 38 N. | 53 E. | 33 | NE¼ NE¼ | IRR | 0.257 | 62.6 | 25 Corporation, Inc. | |
| 2480 | 8 | CER | 11157 | 37 N. | 53 E. | 21 | NE¼ SW¼ | IRR | 0.240 | 58.6 | Munson, Freda F. Bank-1/2 Interest; Secrist, John D. & Marian L.-1/2 Interest | |
| 3474 | 118 | CER | 3609 | 34 N. | 51 E. | 29 | SW¼ SE¼ | IRR | | 29.84 | Charles Drake | |
| 6969 | 9 | CER | 1680 | 33 N. | 52 E. | 26 | SW¼ SE¼ | OTH | 6.570 | 576.0 | Nevada Land & Resource Company, LLC; Vogeler, A.H.; Vogeler, Mary B. | |
| 7887 | 83 | CER | 2540 | 38 N. | 53 E. | 34 | SE¼ NE¼ | STK | 0.022 | 10.1 | W.T. Jenkins Co. | |
| 8246 | 10 | CER | 2233 | 37 N. | 53 E. | 10 | SE¼ SW¼ | STK | 0.082 | 37.7 | BLM | |
| 10299 | 84 | CER | 2811 | 37 N. | 53 E. | 3 | SW¼ SE¼ | MM | 0.500 | 361.9 | Huber, Albert H.; Oldham, John | |
| 18552 | 11 | CER | 6423A | 33 N. | 52 E. | 9 | SE¼ SE¼ | IRR | 5.143 | 809.9 | Newmont/Robert HHadley | |
| 31193S01 | 33 | CER | 14197 | 33 N. | 52 E. | 26 | SE¼ SW¼ | IRR | | N.S. | Carlin-City | |
| 35659 | 12 | CER | 11721 | 37 N. | 53 E. | 10 | SW¼ SE¼ | STK | 0.011 | 5.1 | BLM | |

# Table A-2 (Continued)
## Surface Water Rights and Application for Surface Water Rights

| App # | Map$^1$ # | Status Permit/ Certificate$^2$ | Certificate Number | Township | Range | Section | Subdivision | Use$^3$ | Diversion Rate (CFS) | Annual Duty (Acre-Feet)$^4$ | Owner | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45509 | 85 | CER | 11660 | 33 N. | 51 E. | 10 | SE¼ NW¼ | STK | 0.346 | 84.2 | Newmont Gold Company | |
| 63506 | 86 | PER | | 33 N. | 52 E. | 26 | NW¼ NE¼ | IRR | 0.350 | 15.8 | Newmont Gold Company | |
| R04600 | 13 | RES | | 38 N. | 53 E. | 26 | SE¼ SE¼ | OTH | 0.007 | N.S. | BLM | |
| V06241 | 15 | VST | | 37 N. | 51 E. | 18 | NE¼ NE¼ | STK | 0.006 | N.S. | 26 Ranch Inc. | |
| V06243 | 51 | VST | | 37 N. | 51 E. | 21 | SE¼ NE¼ | STK | 0.006 | N.S. | 26 Ranch Inc. | |
| V06244 | 52 | VST | | 37 N. | 51 E. | 21 | SE¼ NW¼ | STK | 0.002 | N.S. | 26 Ranch Inc. | |
| V06245 | 53 | VST | | 37 N. | 51 E. | 16 | SE¼ SE¼ | STK | 0.002 | N.S. | 26 Ranch Inc. | |
| V06246 | 54 | VST | | 37 N. | 51 E. | 26 | NW¼ SE¼ | STK | 0.003 | N.S. | 26 Ranch Inc. | |
| V06247 | 16 | VST | | 37 N. | 52 E. | 11 | SW¼ NE¼ | STK | 0.002 | N.S. | 26 Ranch Inc. | |
| V06248 | 17 | VST | | 37 N. | 51 E. | 1 | SW¼ SW¼ | STK | 0.006 | N.S. | 26 Ranch Inc. | |
| V06249 | 18 | VST | | 37 N. | 53 E. | 5 | SW¼ NE¼ | STK | 0.005 | N.S. | 26 Ranch Inc. | |
| V06250 | 19 | VST | | 37 N. | 53 E. | 7 | SE¼ SE¼ | STK | 0.006 | N.S. | 26 Ranch Inc. | |
| V06251 | 20 | VST | | 38 N. | 53 E. | 22 | NE¼ SW¼ | STK | 0.006 | N.S. | 26 Ranch Inc. | |
| V06252 | 21 | VST | | 38 N. | 53 E. | 17 | SW¼ SE¼ | STK | 0.003 | N.S. | 26 Ranch Inc. | |
| V06254 | 22 | VST | | 38 N. | 52 E. | 3 | SE¼ SE¼ | STK | | N.S. | 26 Ranch Inc. | |
| Basin 52 – Marys Creek Area | | | | | | | | | | | | |
| 04723 | 35 | VST | | 32 N. | 51 E. | 35 | NE¼ SE¼ | DOM | 0.000 | N.S. | Johnson, Leo N. | |
| 20075 | 87 | CER | 6043 | 32 N. | 51 E. | 35 | SE¼ NE¼ | DOM | 0.002 | 1.6 | Palisade Ranch, Inc. | |
| 31214 | 88 | CER | 10430 | 33 N. | 52 E. | 33 | NE¼ NE¼ | DEC | 0.132 | 32.1 | Jones, Melvin R.; Jones, Rachel S. | |
| 31215 | 89 | CER | 10431 | 33 N. | 52 E. | 33 | NE¼ NE¼ | DEC | 0.278 | 67.8 | Jones, Melvin R.; Jones, Rachel S. | |
| 31216 | 90 | CER | 10432 | 33 N. | 52 E. | 33 | NE¼ NE¼ | DEC | 1.240 | 32.1 | Jones, Melvin R.; Jones, Rachel S. | |
| 46299 | 23 | RFA | | 32 N. | 51 E. | 11 | NE¼ SW¼ | STK | 0.100 | N.S. | Palisade Ranch Inc. | Application Only |
| 50434 | 24 | PER | | 33 N. | 52 E. | 28 | SE¼ | MUN | 0.144 | 35.2 | Carlin-City | |
| 50437 | 25 | PER | | 33 N. | 52 E. | 28 | SW¼ SE¼ | MUN | 1.000 | N.S. | Carlin-City | |
| 50438 | 26 | PER | | 33 N. | 52 E. | 28 | SW¼ SE¼ | MUN | 3.000 | N.S. | Carlin-City | |
| 50439 | 27 | PER | | 33 N. | 52 E. | 28 | SW¼ SE¼ | MUN | 0.770 | N.S. | Carlin-City | |
| 62455 | 28 | PER | | 32 N. | 52 E. | 5 | SE¼ SW¼ | STK | 0.003 | 1.7 | Palisade Ranch Inc. | |
| 62456 | 29 | PER | | 32 N. | 51 E. | 17 | SE¼ SE¼ | STK | 0.003 | 1.7 | Palisade Ranch Inc. | |
| 62467 | 30 | RFA | | 32 N. | 52 E. | 4 | NE¼ NW¼ | DEC | 2.860 | N.S. | Newmont Gold Company; Palisade Ranch | Application Only |
| 62468 | 31 | PER | | 32 N. | 52 E. | 4 | NE¼ NW¼ | DEC | 2.577 | 560.9 | Newmont Gold Company; Palisade Ranch | |
| 62469 | 32 | PER | | 32 N. | 52 E. | 4 | NE¼ NW¼ | DEC | 5.347 | 1073.2 | Newmont Gold Company; Palisade Ranch | |
| V01580 | 91 | VST | | 32 N. | 51 E. | 35 | SE¼ SW¼ | OTH | 0.060 | N.S. | Central Pacific Railroad Co. | |
| V01582 | 34 | VST | | 33 N. | 52 E. | 28 | SW¼ SE¼ | OTH | 0.000 | N.S. | Central Pacific Railway Co. | |
| Basin 61 – Boulder Flat | | | | | | | | | | | | |
| 00168 | $^6$ | PRO | | | | | | DEC | | 1072.52 | Roy Ash/Charles Thorton $^4$ | |
| 00171 | $^6$ | PRO | | | | | | DEC | | 1815.9 | William Dunphy/Newmont $^4$ | |

# Surface Water Rights and Application for Surface Water Rights

| App # | Map[1] # | Status Permit/ Certificate[2] | Certificate Number | Township | Range | Section | Subdivision | Use[3] | Diversion Rate (CFS) | Annual Duty (Acre-Feet)[4] | Owner | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 00333 | [6] | PRO | | | | | | DEC | | 13488.2[7] | Roy Ash/Charles Thorton [4] | |
| 2345 | 36 | PER | 1903 | 33 N. | 50 E. | 18 | SE¼ NE¼ | IRR | 1.250 | 455.0 | Elko Land & Livestock | |
| 3035 | 37 | CER | 11160 | 36 N. | 49 E. | 15 | SW¼ SW¼ | IRR | 3.154 | 675.8 | Packer, Willis; Rhoade, Sharon; Rhoads, Dean | |
| 3146 | 38 | CER | 11162 | 35 N. | 49 E. | 8 | NE¼ NE¼ | IRR | 0.812 | 53.0 | Fox, Almond C. | |
| 3147 | 39 | CER | 11163 | 35 N. | 49 E. | 8 | SE¼ SW¼ | IRR | 1.286 | 139.4 | Fox, Almond C. | |
| 4034 | 40 | CER | 1913 | 33 N. | 50 E. | 18 | NW¼ NW¼ | DOM | 0.025 | N.S. | Weber, Thomas R. | |
| 7626 | 41 | CER | 1624 | 32 N. | 50 E. | 14 | NE¼ NE¼ | DOM | 0.025 | 18.1 | Primeaux, Roy L. | |
| 7657 | 42 | CER | 2517 | 32 N. | 50 E. | 12 | SW¼ SE¼ | DOM | 0.006 | 4.4 | Lewis. H. E. | |
| 7932 | 43 | CER | 8109 | 32 N. | 45 E. | 16 | NW¼ SW¼ | IRR | 5.505 | 1761.6 | Lander County; Licking, Lillian F.; Venturacci, Eddie; Venturacci, Gloria; Veturacci, Leila;Venturacci, Louie | |
| 9822 | 44 | CER | 3939 | 31 N. | 49 E. | 11 | SE¼ NW¼¼ | IRR | 8.835 | 1744.9 | Horseshoe Ranch Inc. | |
| 10733 | 45 | CER | 3347 | 32 N. | 45 E. | 13 | SE¼ SW | IRR | 0.000 | 694.9 | Lander County; Licking, Lillian F.; Venturacci, Eddie; Venturacci, Gloria; Veturacci, Leila;Venturacci, Louie | |
| 16842 | 46 | CER | 4458 | 32 N. | 50 E. | 14 | N¼E NE¼ | DOM | 0.007 | N.S. | Transportation Dept. - Nevada | |
| 55272 | 119 | PER | | 35 N. | 49 E. | 3 | NE¼ NW¼ | STO | 100.0 | | Barrick Goldstrike Mines, Inc. | Primary storage right at the TS Ranch Reservoir associated with mine dewatering rights |
| 55272 S01 | 92 | PER | | 35 N. | 49 E. | 3 | NE¼ NW¼ | IRR | 80.000 | 21612.0 | Barrick Goldstrike Mines, Inc. | Secondary storage right at the TS Ranch Reservoir associated with mine dewatering rights |
| 55272 S02 | 93 | PER | | 35 N. | 49 E. | 3 | NE¼ NW¼ | STK | 0.100 | 22.4 | Barrick Goldstrike Mines, Inc. | Secondary storage right at the TS Ranch Reservoir associated with mine dewatering rights |
| 55272 S03 | 94 | PER | | 35 N. | 49 E. | 3 | NE¼ NW¼ | IRR | 18.000 | 7200.0 | Barrick Goldstrike Mines, Inc. | Secondary storage right at the TS Ranch Reservoir associated with mine dewatering rights |
| 55272 S04 | 95 | PER | | 35 N. | 49 E. | 3 | NE¼ NW¼ | STK | 1.000 | 45.9 | Barrick Goldstrike Mines, Inc. | Secondary storage right at the TS Ranch Reservoir associated with mine dewatering rights |

## Table A-2 (Continued)
## Surface Water Rights and Application for Surface Water Rights

| App # | Map[1] # | Status Permit/ Certificate[2] | Certificate Number | Township | Range | Section | Subdivision | Use[3] | Diversion Rate (CFS) | Annual Duty (Acre-Feet)[4] | Owner | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 55272 S06 | 97 | PER | | 35 N. | 49 E. | 3 | NE¼ NW¼ | IRR | 100.000 | 72000.0 | Barrick Goldstrike Mines, Inc. | Secondary storage right at the TS Ranch Reservoir associated with mine dewatering rights |
| 55272 S07 | 98 | PER | | 35 N. | 49 E. | 3 | NE¼ NW¼ | IRR | 10.000 | 7239.7 | Barrick Goldstrike Mines, Inc. | Secondary storage right at the TS Ranch Reservoir associated with mine dewatering rights |
| 55272 S08 | 99 | PER | | 35 N. | 49 E. | 3 | NE¼ NW¼ | STK | 0.100 | 47.0 | Barrick Goldstrike Mines, Inc. | Secondary storage right at the TS Ranch Reservoir associated with mine dewatering rights |
| 55272 SO9 | 120 | PER | | 35 N. | 49 E. | 3 | NE¼ NW¼ | STK | 0.065 | | Barrick Goldstrike Mines, Inc. | Secondary storage right at the TS Ranch Reservoir associated with mine dewatering rights |
| 55272 S010 | 100 | PER | | 35 N. | 49 E. | 3 | NE¼ NW¼ | WLD | 10.000 | 7238.7 | Barrick Goldstrike Mines, Inc. | Secondary storage right at the TS Ranch Reservoir associated with mine dewatering rights |
| 55272 S011 | 101 | PER | | 35 N. | 49 E. | 3 | NE¼ NW¼ | WLD | 45.000 | 32574.2 | Barrick Goldstrike Mines, Inc. | Secondary storage right at the TS Ranch Reservoir associated with mine dewatering rights |
| 55272 S013 | 103 | PER | | 35 N. | 49 E. | 3 | NE¼ NW¼ | STK | 2.000 | 1447.9 | Barrick Goldstrike Mines, Inc. | Secondary storage right at the TS Ranch Reservoir associated with mine dewatering rights |
| V06227 | 47 | VST | | 33 N. | 46 E. | 15 | NW¼ SE¼ | STK | 0.016 | N.S. | 26 Ranch Inc. | |
| V06236 | 48 | VST | | 36 N. | 49 E. | 5 | SW¼ SE¼ | STK | | N.S. | 26 Ranch Inc. | |
| V06238 | 49 | VST | | 37 N. | 50 E. | 10 | SE¼ NW¼ | STK | | N.S. | 26 Ranch Inc. | |
| V06240 | 14 | VST | | 37 N. | 50 E. | 10 | LT01 (NE¼ NE¼) | STK | 0.006 | N.S. | 26 Ranch Inc. | |
| V06242 | 50 | VST | | 37 N. | 50 E. | 28 | SE¼ NW¼ | STK | 0.003 | N.S. | 26 Ranch Inc. | |
| Basin 62 – Rock Creek Valley | | | | | | | | | | | | |
| 19 | 55 | CER | 97 | 37 N. | 47 E. | 18 | SW¼ SW¼ | IRR | 1.500 | 600.0 | 25 Corporation | |
| 27455 | 105 | CER | 8343 | 38 N. | 49 E. | 29 | NW¼ SW¼ | STK | 0.006 | 4.1 | 25 Corporation, Inc. | |
| 27456 | 106 | CER | 8344 | 38 N. | 49 E. | 28 | NW¼ SW¼ | STK | 0.009 | 6.4 | 25 Corporation, Inc. | |
| 27457 | 107 | CER | 8345 | 33 N. | 46 E. | 11 | SW¼ NW¼ | STK | 0.047 | 33.9 | 25 Corporation, Inc. | |
| 27658 | 108 | CER | 8346 | 37 N. | 49 E. | 8 | NW¼ SE¼ | STK | 0.022 | 16.1 | 25 Corporation, Inc. | |
| 27659 | 109 | CER | 8347 | 34 N. | 46 E. | 28 | SW¼ SW¼ | STK | 0.047 | 33.9 | 25 Corporation, Inc. | |
| 27693 | 110 | CER | 8644 | 36 N. | 46 E. | 7 | SE¼ NW¼ | STK | 0.033 | 23.6 | 25 Corporation, Inc. | |
| 27695 | 111 | CER | 8623 | 36 N. | 46 E. | 5 | SE¼ SE¼ | STK | 0.033 | 23.6 | 25 Corporation, Inc. | |

# Surface Water Rights and Application for Surface Water Rights

| App # | Map[1] # | Status Permit/ Certificate[2] | Certificate Number | Township | Range | Section | Subdivision | Use[3] | Diversion Rate (CFS) | Annual Duty (Acre-Feet)[4] | Owner | Comment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 46744 | 56 | CER | 12245 | 37 N. | 48 E. | 18 | NE¼ NE¼ | STK | 0.017 | 12.3 | BLM | |
| V06228 | 57 | VST | | 33 N. | 46 E. | 16 | NE¼ SE¼ | STK | 0.003 | N.S. | 26 Ranch Inc. | |
| V06229 | 58 | VST | | 33 N. | 46 E. | 11 | SW¼ NW¼ | STK | 0.003 | N.S. | 26 Ranch Inc. | |
| V06232 | 59 | VST | | 36 N. | 46 E. | 7 | SE¼ NW¼ | STK | 0.016 | N.S. | 26 Ranch Inc. | |
| V06233 | 60 | VST | | 34 N. | 46 E. | 28 | SW¼ SW¼ | STK | 0.013 | N.S. | 26 Ranch Inc. | |
| V06234 | 61 | VST | | 37 N. | 48 E. | 6 | LT07 (NE¼ NE¼) | STK | | N.S. | 26 Ranch Inc. | |
| V06235 | 62 | VST | | 37 N. | 48 E. | 12 | NE¼ SW¼ | STK | | N.S. | 26 Ranch Inc. | |
| V06237 | 63 | VST | | 37 N. | 49 E. | 21 | NW¼ NE¼ | STK | | N.S. | 26 Ranch Inc. | |
| V06239 | 64 | VST | | 36 N. | 46 E. | 5 | SE¼ SE¼ | STK | | N.S. | 26 Ranch Inc. | |
| V06261 | 65 | VST | | 38 N. | 49 E. | 32 | SE¼ NW¼ | STK | 0.005 | N.S. | 26 Ranch Inc. | |
| V06262 | 66 | VST | | 38 N. | 49 E. | 32 | SE¼ NW¼ | STK | 0.005 | N.S. | 26 Ranch Inc. | |
| V06263 | 67 | VST | | 38 N. | 49 E. | 35 | SW¼ NE¼ | STK | 0.016 | N.S. | 26 Ranch Inc. | |
| Basin 63 – Willow Creek Valley | | | | | | | | | | | | |
| 1486 | 112 | CER | 256 | 39 N. | 47 E. | 7 | SW¼ NE¼ | IRR | 3.540 | N.S. | Barrick Goldstrike Mines, Inc. | |
| 1487 | 113 | CER | 182 | 39 N. | 46 E. | 22 | E2 NW¼ | STK | 0.056 | 40.5 | Barrick Goldstrike Mines, Inc. | |
| 1760 | 114 | PER | | 39 N. | 48 E. | 27 | | IRR | 29.770 | 21555.8 | Barrick Goldstrike Mines, Inc. | |
| 1997 | 68 | CER | 231 | 39 N. | 46 E. | 15 | SE¼ SW¼ | MM | 0.100 | 72.4 | Rex Mines Company | |
| 3930 | 69 | CER | 1318 | 38 N. | 48 E. | 17 | NW¼ NW¼ | STK | 0.188 | N.S. | Russell Land and Cattle Company | |
| 3931 | 70 | CER | 1319 | 38 N. | 48 E. | 20 | SW¼ NW¼ | STK | 0.019 | N.S. | Russell Land and Cattle Company | |
| 10208 | 115 | CER | 2673 | 39 N. | 48 E. | 27 | NE¼ SW¼ | IRR | | 21555.8 | Barrick Goldstrike Mines, Inc. | |
| 26445 | 71 | CER | 8818 | 39 N. | 46 E. | 20 | NE¼ SE¼ | QM | 0.050 | 1.8 | Kratz, Albert G.; Lukens, Edwin R.;Tieber, Betty Jane; Tieber, Stephen V. | |
| 27488 | 72 | CER | 8638 | 39 N. | 46 E. | 20 | NW¼ SE¼ | QM | 0.009 | 1.1 | Baker, Joseph; Pullen, Loretta; Swindlehurst, Donald; Timmons,Edna G.; Timmons, Wilbur V. | |
| 31184 | 73 | CER | 9284 | 39 N. | 46 E. | 9 | SE¼ SW¼ | QM | 0.011 | 7.9 | Midas Water | |
| 42837 | 74 | CER | 11785 | 39 N. | 46 E. | 20 | NW¼ SE¼ | DOM | 0.001 | 0.8 | Murdock, John G. | |
| 46406 | 75 | CER | 13952 | 39 N. | 46 E. | 20 | NE¼ NW¼ | DOM | 0.005 | 3.2 | Wilkerson, Byron L. | |
| R05587 | 76 | RES | | 41 N. | 49 E. | 32 | SW¼ NW¼ | OTH | 0.002 | N.S. | BLM | |
| R09057 | 116 | RES | | 41 N. | 48 E. | 34 | SW¼ SW¼ | OTH | 0.013 | 9.2 | BLM | |
| V06255 | 77 | VST | | 38 N. | 50 E. | 10 | NE¼ NW¼ | STK | 0.005 | N.S. | 26 Ranch Inc. | |
| V06256 | 78 | VST | | 38 N. | 50 E. | 15 | NW¼ NE¼ | STK | 0.005 | N.S. | 26 Ranch Inc. | |
| V06257 | 79 | VST | | 38 N. | 50 E. | 16 | SE¼ SE¼ | STK | 0.003 | N.S. | 26 Ranch Inc. | |
| V06258 | 80 | VST | | 38 N. | 50 E. | 21 | SE¼ SE¼ | STK | 0.003 | N.S. | 26 Ranch Inc. | |
| V06259 | 81 | VST | | 38 N. | 50 E. | 8 | SW¼ SW¼ | STK | 0.016 | N.S. | 26 Ranch Inc. | |
| V06260 | 82 | VST | | 38 N. | 50 E. | 5 | NE¼ SE¼ | STK | 0.016 | N.S. | 26 Ranch Inc. | |

## Table A-2 (Continued)
## Surface Water Rights and Application for Surface Water Rights

[1] Refer to Figure 3.2-11.

[2] Status:
- APP - Application
- CER - Certificate
- PER - Permit
- RFA – Ready for Action
- RFP - Ready for Action (protested)
- VST - Vested Right
- RES - Reserved
- PRO - Proof (Decreed)

[3] Use:
- COM - Commercial
- DEC - as decreed
- DOM - Domestic
- ENV - Environmental
- IND - Industrial
- IRD - Irrigation (DLE)
- IRR - Irrigation
- MM - Mining and Milling
- MUN - Municipal
- OTH - Other
- QM - Quasi-municipal
- REC - Recreation
- REL - Relinquished (to state)
- STK - Stock Watering
- WLD - Wildlife

[4] Annual Duty - Annual or Seasonal Amounts
N.S. - Not Specified

[5] Current Ownership Record, Transfer in Progress

[6] Dispersed Points of Diversion, Not Illustrated on Map (Harvest, Meadow, or Div. Pasture)

[7] Newmont Gold Record

# APPENDIX B

# WATER QUALITY

## Table B-1

## Nevada Standards for Toxic Materials Applicable to Class A, B, C and Waters Upstream and Tributary to the Humboldt River

| Constituent | Units | Municipal or Domestic Supply | Propagation of Aquatic Life (warm water) | | | Propagation of Wildlife | Water Contact Recreation | Irrigation | Watering of Livestock |
|---|---|---|---|---|---|---|---|---|---|
| | | | Single Value Limit | 1-hour Avg. | 96-hour Avg. | | | | |
| **Inorganic Nonmettalic Constituents** | | | | | | | | | |
| Cyanide | mg/L as CN | 0.2 | | 0.022 | 0.0052 | | | | |
| Fluoride | mg/L as F | | | | | | | 1.0 | 2.0 |
| **Metals and Semi-metals[1]** | | | | | | | | | |
| Antimony | µg/L as Sb | 146 | | | | | | | |
| Arsenic (total) | µg/L as As | 50 | | | | | | 100 | 200 |
| Arsenic (III) | µg/L as As | | | 342[2] | 180[2] | | | | |
| Barium | µg/L as Be | 2000 | | | | | | | |
| Beryllium | µg/L as Be | 0 | | | | | | 100 | |
| Boron | µg/L as B | | | | | | | 750 | 5,000 |
| Cadmium | µg/L as Cu | 5 | | 5.3[2,3] | 1.3[2,3] | | | 10 | 50 |
| Chromium (total) | µg/L as Cr | 100 | | | | | | 100 | 1,000 |
| Chromium (III) | µg/L as Cr | | | 2,057[2,3] | 245[2,3] | | | | |
| Chromium (VI) | µg/L as Cr | | | 15[2] | 10[2] | | | | |
| Copper | µg/L as Cu | | | 22.1[2,3] | 14.2[2,3] | | | 200 | 500 |
| Iron | µg/L as Fe | | 1,000 | | | | | 5,000 | |
| Lead | µg/L as Pb | 50 | | 68.4[2,3] | 1.3[2,3] | | | 5,000 | 100 |
| Manganese | µg/L as Mg | | | | | | | 200 | |
| Mercury | µg/L as Hg | 2 | | 2[2] | 0.012 | | | | 10 |
| Molybdenum | µg/L as Mo | | 19 | | | | | | |
| Nickel | µg/L as Ni | 13.4 | | 1,699[2,3] | 189[2,3] | | | 200 | |
| Selenium | µg/L as Se | 50 | | 20 | 5.0 | | | 20 | 50 |
| Silver | µg/L as Ag | | 6.9[2,3] | | | | | | |
| Thallium | µg/L as Tl | 13 | | | | | | | |
| Zinc | µg/L as Zn | | | 140[2,3] | 127[2,3] | | | 2,000 | 25,000 |

Source: Nevada Administrative Code 445A.144.

[1] The standards for metals are expressed as total recoverable, unless otherwise noted.

[2] Standard applies to the dissolved fraction.

[3] Hardness-derived standard (Nevada Administrative Code 445A.144). Values calculated assuming a hardness of 150 mg/L as $CaCO_3$.

Single concentration limits and 24-hour average concentration limits must not be exceeded; one-hour average and 96-hour average concentration limits may be exceeded only once every 3 years.

## Table B-2
## Selected Water Quality Standards for Class A, B, C, and Waters Upstream and Tributary to the Humboldt River

| Item | Class A Specification | Class B Specification | Class C Specification | Waters Tributary to the Humboldt River Upstream of Battle Mountain and Palisade Control Points |
|---|---|---|---|---|
| Floating Solids or Sludge Deposits | None attributed to human activities | See Nevada Administrative Code 445A.125 | See Nevada Administrative Code 445A.126 | See Nevada Administrative Code 445A.121 |
| Odor-Producing Substances | None attributed to human activities | See Nevada Administrative Code 445A.125 | Not specified | See Nevada Administrative Code 445A.121 |
| Sewage, Industrial Wastes, or Other Wastes | None allowed | None that are not effectively treated to the satisfaction of the department | None that are not effectively treated to the satisfaction of the department | See Nevada Administrative Code 445A.121 |
| Toxic Materials, Oil, Deleterious Substances, Colored or Other Wastes | None allowed | See Nevada Administrative Code 445A.125 | See Nevada Administrative Code 445A.126 | See Nevada Administrative Code 445A.121 |
| Settleable Solids | See Nevada Administrative Code 445A.124 | See Nevada Administrative Code 445A.125 | See Nevada Administrative Code 445A.126 | See Nevada Administrative Code 445A.121 |
| pH | Range between 6.5 and 8.5 | Range between 6.5 to 8.5 | Range between 6.5 to 8.5 | Range between 6.5 to 9.0 and maximum ΔpH±0.5 |
| Dissolved Oxygen | Must not be less than 6.0 mg/L | For trout waters, not less than 6.0 mg/L; for nontrout waters, not less than 5.0 mg/L | For waters with trout, not less than 6.0 mg/L; for waters without trout, not less than 5.0 mg/L | ≥ 5.0 mg/L |
| Temperature | Must not exceed 20° C; allowable temperature increase above natural receiving water temperature: None | Must not exceed 20°C for trout waters or 24°C for nontrout waters; allowable temperature increase above natural receiving water temperatures: None | Must not exceed 20°C for trout waters or 34°C for nontrout waters; allowable temperature increase above normal receiving water temperatures: 3°C | Maximum ΔTemperature ≤ 2°C |
| Nitrate Species | Not Specified | Not Specified | Not Specified | Nitrate ≤ 10 mg/L; Nitrite ≤ 10 mg/L; and un-ionized ammonia ≤ 0.02 mg/L |
| Chloride | Not Specified | Not Specified | Not Specified | ≤ 250 mg/L |
| Sulfate | Not Specified | Not Specified | Not Specified | ≤ 250 mg/L |
| Total Phosphates | Must not exceed 0.15 mg/L in any stream at the point where it enters any reservoir or lake, nor 0.075 mg/L in any reservoir or lake, nor 0.30 mg/L in streams and other flowing waters | Must not exceed 0.3 mg/L | Must not exceed 1.0 mg/L | Total Phosphorus: April – November seasonal average ≤ 0.1 mg/L |
| Turbidity | Not Specified | Not Specified | Not Specified | ≤ 50 NTU |
| Suspended Solids | Not Specified | Not Specified | Not Specified | Annual Median ≤ 80 mg/L |
| Total Dissolved Solids | Must not exceed 500 mg/L or one-third above that characteristic of natural conditions (whichever is less) | Must not exceed 500 mg/L or one-third above that characteristic of natural conditions (whichever is less) | Must not exceed 500 mg/L or one-third above that characteristic of natural conditions (whichever is less) | Annual average ≤ 500 mg/L |

Source: Nevada Administrative Code 445A 124 through 445A-126 and 445A-204 and 445A-205.

## Table B-3
## Stream Water Quality Summary

| Constituent | Units | Maggie Creek[1] | | | | Rock Creek | | Boulder Creek | |
|---|---|---|---|---|---|---|---|---|---|
| | | *n* | min | max | avg | *n* | Value | *n* | Value |
| **Stream Discharge** | cfs | 5 | 0.09 | 2.49 | 0.75 | 1 | 2.6 | 1 | 36.9 |
| **Physical and Aggregrate Properties** | | | | | | | | | |
| SAR | ratio | 5 | 1.2 | 1.4 | 1.3 | 1 | 1.9 | 1 | 0.5 |
| Temperature | °C | 5 | 0.5 | 26 | 7.6 | 1 | 4 | 1 | 7 |
| TDS | mg/L @180°C | 5 | 372 | 460 | 399 | 1 | 263 | 1 | 134 |
| Turbidity | NTU | 5 | 0.3 | 2.4 | 1.5 | 1 | 2.6 | 1 | 50 |
| **Inorganic Nonmetallic Constituents** | | | | | | | | | |
| Chloride | mg/L as Cl | 5 | 19 | 32 | 21 | 1 | 22 | 1 | 4 |
| Cyanide | µg/L as CN | 5 | <0.01 | <0.01 | <0.01 | 1 | <0.01 | 1 | <0.01 |
| Dissolved Oxygen | mg/L as $O_2$ | 5 | 9.4 | 13 | 12 | 1 | 11.6 | 1 | 10 |
| Fluoride | mg/L as F | 5 | 0.3 | 0.6 | 0.4 | 1 | 0.6 | 1 | 0.2 |
| Nitrate | mg/L as N | 5 | 0.45 | 1.4 | 0.94 | | -- | | -- |
| Nitrite | mg/L as N | 5 | 0.01 | 0.08 | 0.02 | 1 | <0.01 | 1 | <0.01 |
| pH | standard units | 5 | 8.1 | 8.8 | 8.4 | 1 | 8.4 | 1 | 7.9 |
| Sulfate | mg/L as $SO_4$ | 5 | 57 | 96 | 73 | 1 | 31 | 1 | 23 |
| Total Ammonia | mg/L as N | 5 | 0.01 | 0.03 | 0.02 | 1 | 0.02 | 1 | 0.02 |
| **Metals (dissolved)** | | | | | | | | | |
| Aluminum | µg/L as Al | 5 | 5 | 10 | 5.6 | 1 | 120 | 1 | 340 |
| Arsenic | µg/L as As | 5 | 6 | 25 | 12 | 1 | 6 | 1 | 3 |
| Barium | µg/L as Ba | 5 | 91 | 110 | 97 | 1 | 60 | 1 | 57 |
| Beryllium | µg/L as Be | 5 | <0.5 | <0.5 | <0.5 | 1 | <0.5 | 1 | <0.5 |
| Cadmium | µg/L as Cd | 5 | 0.5 | 1 | 0.6 | 1 | <1 | 1 | <1 |
| Chromium | µg/L as Cr | 5 | 0.5 | 8 | 1.5 | 1 | <1 | 1 | <1 |
| Copper | µg/L as Cu | 5 | 0.5 | 3 | 1 | 1 | <1 | 1 | 2 |
| Iron | µg/L as Fe | 5 | 3 | 11 | 5 | 1 | 130 | 1 | 65 |
| Lead | µg/L as Pb | 5 | <1 | <1 | <1 | 1 | <1 | 1 | <1 |
| Magnesium | µg/L as Mg | 5 | 18 | 26 | 21 | 1 | 7.5 | 1 | 5.7 |
| Manganese | µg/L as Mn | 5 | 6.0 | 130 | 25 | 1 | 19 | 1 | 7 |
| Mercury | µg/L as Hg | 3 | <0.1 | <0.1 | <0.1 | 1 | 0.05 | 1 | -- |
| Molybdenum | µg/L as Mo | 5 | 5 | 10 | 6 | 1 | <10 | 1 | <10 |
| Nickel | µg/L as Ni | 5 | 0.5 | 2 | 1.7 | 1 | <1 | 1 | 2 |
| Selenium | µg/L as Se | 5 | 0.5 | 5 | 1.6 | 1 | <1 | 1 | 1 |
| Silver | µg/L as Ag | 5 | <1 | <1 | <1 | 1 | <1 | 1 | <1 |
| Thallium | µg/L as Tl | 5 | 1.5 | **44** | 11 | 1 | **15** | 1 | 4 |
| **Water Type** | --- | Ca,Na-$HCO_3$ | | | | Na,Ca-$HCO_3$ | | Ca,Mg-$HCO_3$ | |

Source: Data summarized from USGS database.
*n* = sample size.
[1] Data summarized from 2 sampling sites.
See Figure 3.2-15 for sampling locations.

## Table B-3 (continued)
## Stream Water Quality Summary

| Constituent | Units | Antelope Creek[1] | | | | Bell Creek[1] | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | *n* | min | max | avg | *n* | min | max | avg |
| **Physical and Aggregrate Properties** | | | | | | | | | |
| Alkalinity | mg/L as $CaCO_3$ | 5 | 121.5 | 200 | 156 | 36 | 60.5 | 140 | 91.3 |
| TDS | mg/L @180°C | 5 | 184 | 333 | 275 | 36 | 109 | 280 | 185 |
| TSS | mg/L@103-5°C | 4 | 6.1 | 41.7 | 16.5 | 28 | 0.05 | 300 | 33.7 |
| **Inorganic Nonmetallic Constituents** | | | | | | | | | |
| Chloride | mg/L as Cl | 5 | 5 | 26.3 | 17.9 | 36 | 4 | 8.8 | 5.4 |
| Fluoride | mg/L as F | 5 | 0.31 | **3.4** | **1.2** | 36 | 0.2 | 0.6 | 0.3 |
| Nitrate | mg/L as N | 1 | <0.05 | <0.05 | <0.05 | 16 | <0.05 | 0.55 | 0.091 |
| pH | standard units | 5 | 7.6 | 8.4 | 8.1 | 36 | 7.4 | 8.8 | 8.0 |
| Sulfate | mg/L as $SO_4$ | 1 | 36 | 36 | 36 | 26 | 21.2 | 82 | 41.8 |
| **Metals** | | | | | | | | | |
| Arsenic (T) | µg/L as As | 1 | 18 | 18 | 18 | 36 | <1.0 | 17 | 3 |
| Iron (D) | µg/L as Fe | 5 | <1.0 | 120 | 36 | 33 | <10 | 646 | 190 |
| Magnesium (T) | µg/L as Mg | 1 | 330 | 330 | 330 | 36 | 6,700 | 18,000 | 10,600 |
| Manganese (T) | µg/L as Mn | 1 | 33 | 33 | 33 | 36 | <2 | **590** | 51 |
| **Water Type** | --- | Na-$HCO_3$ | | | | Ca,Mg-$HCO_3$ | | | |

| Constituent | Units | Boulder Creek[2] | | | | Brush Creek[1] | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | *n* | min | max | avg | *n* | min | max | avg |
| **Physical and Aggregrate Properties** | | | | | | | | | |
| Alkalinity | mg/L as $CaCO_3$ | 86 | 22 | 100 | 64 | 66 | 84.9 | 220 | 151 |
| TDS | mg/L @180°C | 85 | 72 | 250 | 144 | 66 | 156 | 470 | 282 |
| TSS | mg/L@103-5°C | 66 | 0.05 | 460 | 54.8 | 54 | 0.005 | 92.6 | 11.0 |
| **Inorganic Nonmetallic Constituents** | | | | | | | | | |
| Chloride | mg/L as Cl | 86 | <3 | 40.6 | 5.5 | 66 | 5 | 33 | 14 |
| Fluoride | mg/L as F | 85 | 0.1 | **1.2** | 0.27 | 66 | 0.12 | **1.7** | 0.58 |
| Nitrate | mg/L as N | 50 | <0.05 | 0.71 | 0.13 | 41 | <0.05 | 19 | 0.51 |
| pH | standard units | 85 | 7.1 | 9.0 | 7.9 | 88 | 7.6 | 9.4 | 8.2 |
| Sulfate | mg/L as $SO_4$ | 43 | 8 | 100 | 30 | 47 | 30 | 130 | 67 |
| **Metals** | | | | | | | | | |
| Arsenic (T) | µg/L as As | 95 | <5 | **505** | 15 | 86 | <5 | 42 | 5 |
| Iron (D) | µg/L as Fe | 86 | <10 | **1,310** | 370 | 54 | <10 | 739 | 71 |
| Magnesium (T) | µg/L as Mg | 86 | 4,080 | 21,000 | 774 | 66 | 12,000 | 41,900 | 20,300 |
| Manganese (T) | µg/L as Mn | 86 | <5 | **1,060** | 73 | 65 | <5 | 200 | 17 |
| **Water Type** | --- | Na-$HCO_3$ | | | | Ca,Mg-$HCO_3$ | | | |

Source: Data summarized from the Boulder Valley Monitoring Plan.
*n* = sample size.
[1]Data summarized from 2 sampling sites.
[2]Data summarized from 4 sampling sites.
(T) = Total
(D) = Dissolved
See Figure 3.2-15 for sampling locations.

## Table B-3 (continued)
## Stream Water Quality Summary

| Constituent | Units | Rock Creek[2] | | | | Rodeo Creek[2] | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | *n* | min | max | avg | *n* | min | max | avg |
| **Physical and Aggregrate Properties** | | | | | | | | | |
| Alkalinity | mg/L as $CaCO_3$ | 8 | 107 | 147 | 121 | 78 | 30 | 330 | 120 |
| TDS | mg/L @180°C | 8 | 190 | 258 | 212 | 78 | 130 | 2,300 | 561 |
| TSS | mg/L@103-5°C | 8 | 1.1 | 8.3 | 4.2 | 81 | <5 | 14,000 | 426 |
| **Inorganic Nonmetallic Constituents** | | | | | | | | | |
| Chloride | mg/L as Cl | 8 | 20.4 | 33.3 | 24.9 | 78 | 4 | 1,000 | 140 |
| Fluoride | mg/L as F | 8 | 0.38 | **1.35** | 0.65 | 77 | 0.1 | **1.1** | 0.41 |
| Nitrate | mg/L as N | 0 | --- | --- | --- | 55 | <0.05 | 14 | 1.5 |
| pH | standard units | 8 | 7.8 | 8.7 | 8.3 | 106 | 7.1 | 10.0 | 8.2 |
| Sulfate | mg/L as $SO_4$ | 8 | 34.0 | 40.2 | 36.1 | 61 | 12 | 1,100 | 96 |
| **Metals** | | | | | | | | | |
| Arsenic (T) | µg/L as As | 0 | --- | --- | --- | 107 | <5 | **1,400** | **140** |
| Iron (D) | µg/L as Fe | 8 | 4.9 | 32 | 20 | 54 | <10 | **6,330** | 250 |
| Magnesium (T) | µg/L as Mg | 0 | --- | --- | --- | 78 | 3,700 | 250,000 | 40,000 |
| Manganese (T) | µg/L as Mn | 0 | --- | --- | --- | 78 | <5 | **4,400** | **290** |
| **Water Type** | --- | Na-$HCO_3$ | | | | Ca,Mg-$HCO_3$ | | | |

Source: Data summarized from the Boulder Valley Monitoring Plan.

*n* = sample size.

[1] Data summarized from 2 sampling sites.

[2] Data summarized from 4 sampling sites.

(T) = Total

(D) = Dissolved

See Figure 3.2-15 for sampling locations.

## Table B-4
## Stream Water Quality Summary for Lahontan Cutthroat Trout Streams

| Constituent | Units | Nelson Creek | Lewis Creek | Toe Jam Creek | Upper Rock Creek | Frazer Creek |
|---|---|---|---|---|---|---|
| Sample Date | mm/dy/yr | 8/13/97 | 8/13/97 | 8/14/97 | 8/14/97 | 8/15/97 |
| Stream Discharge | cfs | <0.4 | 0.2-0.3 | 0.09 | 0.29 | 0.15 |
| **Physical and Aggregrate Properties** | | | | | | |
| Alkalinity | mg/L as $CaCO_3$ | 65 | 80 | 65 | 59 | 63 |
| TDS | mg/L @180°C | 100 | 150 | 100 | 90 | 140 |
| Temperature | °C | 23.3 | 17.0 | 16.4 | 14.2 | 15.2 |
| TSS | mg/L @103 C | <5 | <5 | <5 | <5 | <5 |
| Turbidity | NTU | 1.3 | 1.2 | 2.3 | 0.4 | 1.1 |
| **Inorganic Nonmetallic Constituents** | | | | | | |
| Chloride | mg/L as Cl | 4 | 4 | 1 | 1 | 9 |
| Dissolved Oxygen | mg/L as $O_2$ | 7.8 | 6.6 | 8.13 | 5.6 | 9.4 |
| Fluoride | mg/L as F | 0.1 | 0.2 | 0.1 | <0.1 | 0.3 |
| Nitrate | mg/L as N | <0.02 | <0.02 | <0.02 | <0.02 | <0.02 |
| Nitrite | mg/L as N | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| pH, field | su | 8.6 | 7.6 (lab) | 7.9 | 8.4 | 8.1 |
| Phosphorus, ortho | mg/L as P | 0.1 | 0.09 | 0.044 | 0.027 | 0.021 |
| Sulfate | mg/L as $SO_4$ | <10 | <10 | 10 | 10 | 10 |
| Total Ammonia | mg/L as N | 0.19 | 0.09 | <0.05 | <0.05 | 0.09 |
| Total Phosphate | mg/L as $PO_4$ | 0.226 | 0.093 | 0.056 | 0.045 | 0.031 |
| **Metals** | | | | | | |
| Arsenic total | µg/L as As | 3 | 3 | 2 | 5 | 1 |
| Arsenic,dissolved | µg/L as As | 3 | 3 | 2 | 5 | 2 |
| Cadmium, dissolved | µg/L as Cd | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Cadmium, total | µg/L as Cd | <0.5 | <0.5 | <0.5 | <0.5 | <0.5 |
| Chromium, total | µg/L as Cr | 0.4 | 0.6 | 0.7 | 0.4 | 0.5 |
| Chromium, dissolved | µg/L as Cr | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 |
| Copper, dissolved | µg/L as Cu | 4 | 1 | <1 | 1 | 1 |
| Copper, total | µg/L as Cu | 1 | <1 | 2 | 2 | 1 |
| Iron, dissolved | µg/L as Fe | 100 | 140 | 560 | 180 | 130 |
| Iron, total | µg/L as Fe | 100 | 230 | 560 | 210 | 210 |
| Lead, dissolved | µg/L as Pb | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 |
| Lead, total | µg/L as Pb | <0.4 | <0.4 | <0.4 | <0.4 | <0.4 |
| Magnesium, dissolved | µg/L as Mg | 4,400 | 5,800 | 3,700 | 2,900 | 4,300 |
| Manganese, dissolved | µg/L as Mg | 6 | 13 | 10 | 21 | 7 |
| Manganese, total | µg/L as Mg | 9 | 21 | 29 | 21 | 21 |
| Mercury, dissolved | µg/L as Pb | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| Mercury, total | µg/L as Hg | <0.2 | <0.2 | <0.2 | <0.2 | <0.2 |
| Nickel, dissolved | µg/L as Ni | <1 | 1 | <1 | <1 | <1 |
| Nickel, total | µg/L as Ni | <1 | 1 | 1 | <1 | <1 |
| Potassium, dissolved | µg/L as K | 6,000 | 5,000 | 1,500 | 1,100 | 2,300 |
| Selenium, dissolved | µg/L as Se | <1 | <1 | <1 | <1 | <1 |
| Selenium, total | µg/L as Se | <1 | <1 | <1 | <1 | <1 |
| Zinc,dissolved | µg/L as Zn | 10 | 1.0 | <10 | 10 | <10 |
| Zinc, total | µg/L as Zn | 10 | 100 | 10 | 10 | 10 |
| **Water Type** | --- | Ca,Na-$HCO_3$ | Ca,Na-$HCO_3$ | Ca-$HCO_3$ | Ca-$HCO_3$ | Ca,Na-$HCO_3$ |

Source: AATA International, Inc. 1998a

See Figure 3.6-1 for Lahonton Cutthroat Trout stream segment locations.

# APPENDIX C

# HUMBOLDT RIVER INFORMATION

## Table C-1
## Water Withdrawals by County[1]
## (thousands of acre-feet/year)

| Year | Use | Elko | | Eureka | | Humboldt | | Lander | | Pershing | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Flow | Percent | Flow | Percent | Flow | Percent | Flow | Percent | Flow | Percent | Flow | Percent |
| 1990 | Municipal/Industrial | 11.6 | 1.2 | 0.4 | 0.3 | 3.2 | 0.7 | 0.9 | 0.5 | 1.2 | 0.5 | 17.3 | 0.9 |
| | Irrigation/Livestock | 960.4 | 98.3 | 121.2 | 82.2 | 433.8 | 93.4 | 156.1 | 88.8 | 216.4 | 98.6 | 1887.9 | 95.1 |
| | Domestic | 0.8 | 0.1 | 0.1 | 0.1 | 0.6 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 1.9 | 0.1 |
| | Mining | 4.4 | 0.5 | 25.8 | 17.5 | 27.1 | 5.8 | 18.6 | 10.6 | 1.7 | 0.8 | 77.6 | 3.9 |
| 2000 | Municipal/Industrial | 15.6 | 1.5 | 0.5 | 0.2 | 4.5 | 0.8 | 1.3 | 0.5 | 1.7 | 0.8 | 23.6 | 1.0 |
| | Irrigation/Livestock | 1000.7 | 98.3 | 121.3 | 42.8 | 433.8 | 81.4 | 161.9 | 62.1 | 216.4 | 99.1 | 1934.1 | 83.6 |
| | Domestic | 1.2 | 0.1 | 0.1 | 0.0 | 0.8 | 0.2 | 0.3 | 0.1 | 0.3 | 0.1 | 2.7 | 0.1 |
| | Mining | 0.0 | 0.0 | 161.8 | 57.0 | 94.1 | 17.6 | 97.4 | 37.3 | 0.0 | 0.0 | 353.3 | 15.3 |
| 2010 | Municipal/Industrial | 18.9 | 1.8 | 0.6 | 0.3 | 5.4 | 1.2 | 1.6 | 0.9 | 2.1 | 1.0 | 28.6 | 1.3 |
| | Irrigation/Livestock | 1040.9 | 98.1 | 121.4 | 58.9 | 433.9 | 94.1 | 168.2 | 97.7 | 216.4 | 98.9 | 1980.8 | 93.5 |
| | Domestic | 1.4 | 0.1 | 0.1 | 0.0 | 1.0 | 0.2 | 0.3 | 0.2 | 0.3 | 0.1 | 3.1 | 0.1 |
| | Mining | 0.0 | 0.0 | 83.9 | 40.7 | 21.0 | 4.6 | 2.0 | 1.2 | 0.0 | 0.0 | 106.9 | 5.0 |
| 2020 | Municipal/Industrial | 21.9 | 2.0 | 0.7 | 0.6 | 6.3 | 1.4 | 1.9 | 1.1 | 2.4 | 1.1 | 33.2 | 1.6 |
| | Irrigation/Livestock | 1081.2 | 97.9 | 121.6 | 96.9 | 433.9 | 97.9 | 174.0 | 97.6 | 216.5 | 98.7 | 2027.2 | 97.9 |
| | Domestic | 1.6 | 0.1 | 0.2 | 0.2 | 1.2 | 0.3 | 0.4 | 0.2 | 0.4 | 0.2 | 3.8 | 0.2 |
| | Mining | 0.0 | 0.0 | 3.0 | 2.4 | 2.0 | 0.5 | 2.0 | 1.1 | 0.0 | 0.0 | 7.0 | 0.3 |

Source: Nevada Division of Water Planning 1992a, 1992b; Horton 1998.

Flow = thousands of acre-feet/year.

Percent = Percent of total flow withdrawal.

[1] More recently revised agency estimates indicate different levels of water usage than shown in the table (Nevada Division of Water Planning 1998).

### Table C-2
### Consumptive Water Uses by County[1]
### (thousands of acre-feet/year)

| Year | Use | Elko | Eureka | Humboldt | Lander | Pershing | Total |
|---|---|---|---|---|---|---|---|
| 1990 | Municipal/Industrial | 4.4 | 0.2 | 1.3 | 0.4 | 0.5 | 6.6 |
| | Irrigation/Livestock | 515.6 | 73.4 | 227.4 | 83.3 | 110.6 | 1010.3 |
| | Domestic | 0.4 | 0.0 | 0.3 | 0.1 | 0.1 | 1.0 |
| | Mining | 3.9 | 12.5 | 7.0 | 7.4 | 1.6 | 32.4 |
| 2000 | Municipal/Industrial | 5.9 | 0.2 | 1.8 | 0.5 | 0.6 | 9.1 |
| | Irrigation/Livestock | 537.2 | 73.4 | 227.4 | 86.4 | 110.6 | 1035.0 |
| | Domestic | 0.6 | 0.0 | 0.4 | 0.2 | 0.2 | 1.4 |
| | Mining | 0.0 | 19.4 | 13.0 | 6.4 | 0.0 | 38.8 |
| 2010 | Municipal/Industrial | 18.9 | 0.2 | 2.1 | 0.7 | 0.8 | 22.7 |
| | Irrigation/Livestock | 1040.9 | 73.5 | 227.4 | 89.7 | 110.6 | 1542.1 |
| | Domestic | 1.4 | 0.0 | 0.5 | 0.2 | 0.2 | 2.3 |
| | Mining | 0.0 | 19.4 | 8.0 | 2.0 | 0.0 | 29.4 |
| 2020 | Municipal/Industrial | 21.9 | 0.3 | 2.5 | 0.8 | 0.9 | 26.4 |
| | Irrigation/Livestock | 1081.2 | 73.6 | 227.4 | 92.8 | 110.6 | 1585.6 |
| | Domestic | 1.6 | 0.1 | 0.6 | 0.2 | 0.2 | 2.7 |
| | Mining | 0.0 | 3.0 | 2.0 | 2.0 | 0.0 | 7.0 |

Source: Nevada Division of Water Planning 1992a,b; Horton 1998.

[1] More recently revised agency estimates indicate different levels of water usage than shown in the table (Nevada Division of Water Planning 1998).

## Table C-3
## Water Use by Category for 1995 in the Humboldt River Basin

| County | Water Withdrawal (acre-feet/year) | | | |
|---|---|---|---|---|
| | Irrigation/Livestock | Municipal/Industrial | Domestic | Mining |
| Elko | 910,300 | 20,200 | 700 | 5,400 |
| Eureka | 125,000 | 5,100 | 100 | 114,200 |
| Humboldt | 600,500 | 8,100 | 1,400 | 76,600 |
| Lander | 161,700 | 1,400 | 250 | 35,600 |
| Pershing | 117,200 | 1,700 | 150 | 2,100 |
| | | | | |
| **Five-county Total** | **1,914,700 (87.5%)** | **36,500 (1.7%)** | **2,600 (0.1%)** | **233,900 (10.7%)** |

Source: Horton 1998.

## Table C-4
## Water Use by Source for 1995 in the Humboldt River Basin

| County | Water Withdrawal (acre-feet/year) | | | Consumptive Use (acre-feet/year) |
|---|---|---|---|---|
| | Groundwater | Surface Water | Total | |
| Elko | 124,200 | 812,400 | 936,600 | 477,300 (51% of total) |
| Eureka | 220,700 | 23,700 | 244,400 | 93,400 (38% of total) |
| Humboldt | 546,900 | 139,700 | 686,600 | 334,800 (49% of total) |
| Lander | 144,000 | 55,000 | 199,000 | 94,100 (47% of total) |
| Pershing | 40,900 | 80,300 | 121,200 | 65,300 (54% of total) |
| | | | | |
| **Five-county Total** | **1,076,700** | **1,111,100** | **2,187,800** | **1,064,900 (49% of total)** |

Source: Horton 1998.

## Table C-5
## Water Use Forecast for Selected Purveyors in the Humboldt River Basin (1990-2020)

| Water Purveyor | Current Water Supply (acre-feet/year) | Water Use (acre-feet/year) | | | |
|---|---|---|---|---|---|
| | | 1990 | 2000 | 2010 | 2020 |
| Elko County | | | | | |
| Carlin City Water | 4,538 | 777 | 1,186 | 1,381 | 1,559 |
| Elko City Water | 17,154 | 5,957 | 9,829 | 12,378 | 14,926 |
| Eureka County | | | | | |
| Eureka Water Association | 1,522 | 307 | 371 | 460 | 520 |
| Humboldt County | | | | | |
| Winnemucca City Water | 5,854 | 2,540 | 3,192 | 3,696 | 4,167 |
| Lander County | | | | | |
| Lander County Sewer/Water District #1 | 2,896 | 919 | 1,294 | 1,553 | 1,811 |
| Pershing County | | | | | |
| Lovelock City Water | 3,795 | 1,204 | 1,960 | 2,350 | 2,700 |
| Imlay City Water | 560 | 49 | 65 | 82 | 98 |

Source: Nevada Division of Water Planning 1992a.

## Table C-6
## Active NPDES Facility Locations in the Humboldt River Basin

| Permit No. | Facility | City/County | Permitted Flow (cfs) | Discharge Type | Receiving Water |
|---|---|---|---|---|---|
| NV0022675 | Barrick Goldstrike Mines | Carlin/Eureka | 100.8 | Mine Dewatering | Humboldt River |
| NV0021962 | Lone Tree Mining Co. | Valmy/Humboldt | 108.0 | Mine Dewatering | Humboldt River |
| NV0020311 | Lovelock, City of | Lovelock/Pershing | 0.5 | Waste/Process Municipal | Toulon River |
| NV0020656 | NDOW - Gallagher | Elko/Elko | 3.0 | Waste/Process Hatchery | Ruby Marsh |
| NV0022268 | Newmont/Gold Quarry | Carlin/Eureka | 72.0 | Mine Dewatering | Humboldt River |
| NV0021725 | Twin Creeks Mining | Golconda/Humboldt | 14.55 | Mine Pump/Well Test | Humboldt River |

Source: Narala 1999.

## Table C-7
## Water Release from Public Sewage Treatment Facilities in the Humboldt River Basin (1990)

| County | Total Release (gallons/day) | Total Release (acre-feet/year) |
|---|---|---|
| Elko | 3,840,000 | 4,300 |
| Eureka | 60,000 | 70 |
| Humboldt | 890,000 | 1,000 |
| Lander | 460,000 | 520 |
| Pershing | 250,000 | 280 |
| | | |
| **State Total** | **152,230,000** | **170,520** |

Source: Internet - Nevada Division of Water Planning, 1999.

## Table C-8
## Monthly Flow Ranges for 1946-1990, Humboldt River Gages[1]
## (cfs)

| | | Carlin | | | Palisade | |
|---|---|---|---|---|---|---|
| | Minimum | Average | Maximum | Minimum | Average | Maximum |
| Jan | 10 | 148 | 452 | 30 | 176 | 543 |
| Feb | 22 | 287 | 1,324 | 36 | 350 | 1,779 |
| Mar | 107 | 521 | 2,190 | 129 | 634 | 2,949 |
| Apr | 108 | 751 | 3,684 | 121 | 913 | 4,222 |
| May | 79 | 985 | 5,728 | 83 | 1,078 | 5,719 |
| Jun | 67 | 1,228 | 4,876 | 78 | 1,270 | 4,635 |
| Jul | 7 | 377 | 1,908 | 24 | 360 | 1,960 |
| Aug | 1 | 53 | 492 | 92 | 67 | 571 |
| Sep | 1 | 27 | 154 | 10 | 41 | 199 |
| Oct | 18 | 48 | 331 | 15 | 66 | 370 |
| Nov | 6 | 79 | 361 | 23 | 100 | 411 |
| Dec | 7 | 104 | 625 | 24 | 125 | 720 |

| | | Argenta[2] | | | Battle Mountain[2] | |
|---|---|---|---|---|---|---|
| | Minimum | Average | Maximum | Minimum | Average | Maximum |
| Jan | 10 | 166 | 514 | 10 | 178 | 622 |
| Feb | 24 | 329 | 1,528 | 23 | 338 | 1,518 |
| Mar | 108 | 588 | 2,467 | 102 | 614 | 2,713 |
| Apr | 105 | 838 | 4,277 | 97 | 823 | 4,065 |
| May | 52 | 946 | 6,263 | 51 | 950 | 6,465 |
| Jun | 40 | 1,146 | 4,971 | 35 | 1,108 | 4,776 |
| Jul | 7 | 353 | 2,030 | 6 | 371 | 2,055 |
| Aug | 0 | 50 | 519 | 0 | 63 | 658 |
| Sep | 0 | 16 | 111 | 0 | 23 | 177 |
| Oct | 0 | 37 | 297 | 0 | 42 | 351 |
| Nov | 0 | 81 | 403 | 0 | 84 | 419 |
| Dec | 5 | 115 | 743 | 4 | 117 | 727 |

| | | Comus | | | Imlay | |
|---|---|---|---|---|---|---|
| | Minimum | Average | Maximum | Minimum | Average | Maximum |
| Jan | 0 | 152 | 762 | 11 | 126 | 779 |
| Feb | 0 | 280 | 904 | 19 | 203 | 991 |
| Mar | 66 | 582 | 3,267 | 34 | 432 | 1,991 |
| Apr | 94 | 806 | 5,312 | 46 | 596 | 4,489 |
| May | 31 | 850 | 6,227 | 28 | 690 | 6,223 |
| Jun | 25 | 970 | 4,630 | 13 | 732 | 5,355 |
| Jul | 0 | 417 | 1,930 | 1 | 475 | 2,340 |
| Aug | 0 | 64 | 637 | 1 | 122 | 936 |
| Sep | 0 | 17 | 190 | 3 | 48 | 292 |
| Oct | 0 | 32 | 259 | 6 | 46 | 301 |
| Nov | 0 | 64 | 386 | 6 | 66 | 412 |
| Dec | 0 | 105 | 791 | 10 | 97 | 685 |

Source: USGS 1999; RTi 1998.

[1] Input data are daily flows in cfs; these are then averaged for each month of each year in the record.

[2] Includes periods of highly-correlated synthesized data (RTi 1998).

## Table C-9
## General Rainfall Conditions for Recent Years in the Humboldt River Basin

| Recent Year | Annual Precipitation at Battle Mountain | Basin-wide Precipitation for Calendar Year in Upper Humboldt[1] | Basin-wide Precipitation for Calendar Year in Lower Humboldt[1] |
|---|---|---|---|
| 1991 | Almost exactly average | Low | Average to high |
| 1992 | 37% above average | Low | Low |
| 1993 | 8% below average | Average - | Low |
| 1994 | 24% above average | Low | Generally high |
| 1995 | 26% below average | High to very high | High to very high |
| 1996 | 57% above average | High to very high | High to very high |
| 1997 | 16% above average | Average | Average + |
| 1998 | Approx. 116% above average | High to very high | High to very high |

Source: National Climatic Data Center precipitation station data 1999.

[1] Very generally, the upper Humboldt subbasin is upstream of Emigrant Pass/Palisade, and the lower Humboldt subbasin is downstream of Emigrant Pass/Palisade. This corresponds to the administration areas for the Edwards Decree vs Bartlett Decree. Qualitative examinations were based on rating several stations in each subbasin with their historical averages.

## Table C-10
## Comparison of River Flows for 1991 - 1998 with Average Annual Premine Discharge Conditions (1946-1990) [1]

| Recent Year | Elko | Carlin | Battle Mountain | Comus | Imlay |
|---|---|---|---|---|---|
| 1991 | -65% | -60% | -67% | -75% | -80% |
| 1992 | -85% | -80% | -85% | -85% | -90% |
| 1993 | +15% | +5% | +25% | +5% | Average |
| 1994 | -67% | -67% | -67% | -60% | -70% |
| 1995 | +60% | +60% | +50% | +40% | +30% |
| 1996 | +25% | +30% | +70% | +50% | +50% |
| 1997 | +60% | +60% | +125% | +120% | +115% |
| 1998 | +60% | +65% | +110% | +125% | +130% |

Source: USGS 1999.

[1] All percentages are approximate.

## Table C- 11
## Flow Changes Between Humboldt River Gages in Recent High-flow Years Compared with Discharge from the Goldstrike Mine
## (all values are mean monthly flows in cfs)

| | Dunphy Flow | Battle Mtn Flow | Difference (dQ) | Goldstrike Mine Q | Difference[1] Mine Q - dQ | Battle Mtn Flow | Comus Flow | Difference (dQ) | Goldstrike Mine Q | Difference[1] Mine Q – dQ |
|---|---|---|---|---|---|---|---|---|---|---|
| Jan-95 | 125.58 | 108.32 | -17.26 | 0.00 | na | 108.32 | 107.23 | -1.09 | 0.00 | na |
| Feb-95 | 301.29 | 248 | -53.29 | 0.00 | na | 248 | 279.36 | 31.36 | 0.00 | -31.36 |
| Mar-95 | 460.74 | 449.48 | -11.26 | 0.00 | na | 449.48 | 416.55 | -32.93 | 0.00 | na |
| Apr-95 | 508 | 551.27 | 43.27 | 0.00 | -43.27 | 551.27 | 490.87 | -60.4 | 0.00 | na |
| May-95 | 1130.81 | 1164.06 | 33.25 | 0.00 | -33.25 | 1164.06 | 687.32 | -476.74 | 0.00 | na |
| Jun-95 | 2580.67 | 2563.33 | -17.34 | 0.00 | na | 2563.33 | 2060.67 | -502.66 | 0.00 | na |
| Jul-95 | 1300.26 | 1417.87 | 117.61 | 0.00 | -117.61 | 1417.87 | 1450 | 32.13 | 0.00 | -32.13 |
| Aug-95 | 166.03 | 182.94 | 16.91 | 0.00 | -16.91 | 182.94 | 274 | 91.06 | 0.00 | -91.06 |
| Sep-95 | 51.5 | 52.1 | 0.6 | 0.00 | -0.60 | 52.1 | 71.57 | 19.47 | 0.00 | -19.47 |
| Oct-95 | 69.1 | 61.35 | -7.75 | 0.00 | na | 61.35 | 70.87 | 9.52 | 0.00 | -9.52 |
| Nov-95 | 98.4 | 98.2 | -0.2 | 0.00 | na | 98.2 | 113.77 | 15.57 | 0.00 | -15.57 |
| Dec-95 | 106.45 | 113.84 | 7.39 | 0.00 | -7.39 | 113.84 | 126.74 | 12.9 | 0.00 | -12.90 |
| Jan-96 | 177.71 | 181.03 | 3.32 | 0.00 | -3.32 | 181.03 | 199.32 | 18.29 | 0.00 | -18.29 |
| Feb-96 | 452.69 | 446.03 | -6.66 | 0.00 | na | 446.03 | 423 | -23.03 | 0.00 | na |
| Mar-96 | 1240.74 | 1457.06 | 216.32 | 0.00 | -216.32 | 1457.06 | 1114.13 | -342.93 | 0.00 | na |
| Apr-96 | 1369 | 1723.67 | 354.67 | 0.00 | -354.67 | 1723.67 | 1433.33 | -290.34 | 0.00 | na |
| May-96 | 1338.81 | 1604.84 | 266.03 | 0.00 | -266.03 | 1604.84 | 1142.16 | -462.68 | 0.00 | na |
| Jun-96 | 1313.7 | 1606.63 | 292.93 | 0.00 | -292.93 | 1606.63 | 1320.5 | -286.13 | 0.00 | na |
| Jul-96 | 302.32 | 415.1 | 112.78 | 0.00 | -112.78 | 415.1 | 369.1 | -46 | 0.00 | na |
| Aug-96 | 41.1 | 41.74 | 0.64 | 0.00 | -0.64 | 41.74 | 69.39 | 27.65 | 0.00 | -27.65 |
| Sep-96 | 23.6 | 14.5 | -9.1 | 0.00 | na | 14.5 | 38 | 23.5 | 0.00 | -23.50 |
| Oct-96 | 47.65 | 31.65 | -16 | 0.00 | na | 31.65 | 51.65 | 20 | 0.00 | -20.00 |
| Nov-96 | 126.9 | 109.17 | -17.73 | 0.00 | na | 109.17 | 128.03 | 18.86 | 0.00 | -18.86 |
| Dec-96 | 252.74 | 234.84 | -17.9 | 0.00 | na | 234.84 | 211.16 | -23.68 | 0.00 | na |
| Jan-97 | 667.39 | 1123.32 | 455.93 | 0.00 | -455.93 | 1123.32 | 750.42 | -372.9 | 0.00 | na |
| Feb-97 | 564.07 | 812.79 | 248.72 | 0.00 | -248.72 | 812.79 | 774.93 | -37.86 | 0.00 | na |
| Mar-97 | 1432.74 | 1693.03 | 260.29 | 0.00 | -260.29 | 1693.03 | 1304.45 | -388.58 | 0.00 | na |
| Apr-97 | 1249.3 | 1533.33 | 284.03 | 0.00 | -284.03 | 1533.33 | 1604.33 | 71 | 0.00 | -71.00 |
| May-97 | 1682.9 | 1910.97 | 228.07 | 0.00 | -228.07 | 1910.97 | 1482.26 | -428.71 | 0.00 | na |
| Jun-97 | 2046.83 | 2074 | 27.17 | 0.00 | -27.17 | 2074 | 2100 | 26 | 0.00 | -26.00 |
| Jul-97 | 470.48 | 509.87 | 39.39 | 0.00 | -39.39 | 509.87 | 595.68 | 85.81 | 0.00 | -85.81 |

## Table C- 11 (Continued)
## Flow Changes Between Humboldt River Gages in Recent High-flow Years Compared with Discharge from the Goldstrike Mine
## (all values are mean monthly flows in cfs)

| | Dunphy Flow | Battle Mtn Flow | Difference (dQ) | Goldstrike Mine Q | Difference[1] Mine Q - dQ | Battle Mtn Flow | Comus Flow | Difference (dQ) | Goldstrike Mine Q | Difference[1] Mine Q – dQ |
|---|---|---|---|---|---|---|---|---|---|---|
| Aug-97 | 156.35 | 137.77 | -18.58 | 0.00 | na | 137.77 | 149.39 | 11.62 | 0.00 | -11.62 |
| Sep-97 | 42.9 | 63.6 | 20.7 | 8.11 | -12.59 | 63.6 | 81.97 | 18.37 | 8.11 | -10.26 |
| Oct-97 | 76.06 | 168.94 | 92.88 | 126.58 | 33.70 | 168.94 | 174.94 | 6 | 126.58 | 120.58 |
| Nov-97 | 114.23 | 255.83 | 141.6 | 126.58 | -15.02 | 255.83 | 257.63 | 1.8 | 126.58 | 124.78 |
| Dec-97 | 139.61 | 328.13 | 188.52 | 126.58 | -61.94 | 328.13 | 303.32 | -24.81 | 126.58 | na |
| Jan-98 | 301.9 | 426.29 | 124.39 | 100.78 | -23.61 | 426.29 | 476.71 | 50.42 | 100.78 | 50.36 |
| Feb-98 | 350.82 | 440.96 | 90.14 | 100.78 | 10.64 | 440.96 | 578.14 | 137.18 | 100.78 | -36.40 |
| Mar-98 | 642.26 | 703.94 | 61.68 | 100.78 | 39.10 | 703.94 | 714.71 | 10.77 | 100.78 | 90.01 |
| Apr-98 | 1127.33 | 1322.33 | 195 | 49.09 | -145.91 | 1322.33 | 939.27 | -383.06 | 49.09 | na |
| May-98 | 1939.03 | 2262.26 | 323.23 | 49.09 | -274.14 | 2262.26 | 1967.77 | -294.49 | 49.09 | na |
| Jun-98 | 2412.33 | 2918.67 | 506.34 | 49.09 | -457.25 | 2918.67 | 2683.67 | -235 | 49.09 | na |
| Jul-98 | 1218.26 | 1249.9 | 31.64 | 12.10 | -19.54 | 1249.9 | 1621.74 | 371.84 | 12.10 | -359.74 |
| Aug-98 | 215.58 | 210.97 | -4.61 | 12.10 | na | 210.97 | 324.61 | 113.64 | 12.10 | -101.54 |
| Sep-98 | 72.9 | 95.37 | 22.47 | 12.10 | -10.37 | 95.37 | 152.63 | 57.26 | 12.10 | -45.16 |

Source: USGS 1999; Barrick 1999a.

[1] A positive or negative Mine Q – dQ indicates the possibility that some or all of the mine discharge is involved in the flow increase. Relatively large positive Mine Q-dQ may indicate that mine discharges are being significantly withdrawn for other uses (e.g., March 1998). Negative Mine Q – dQ indicates that there is more gain in the streamflow between the gages than can be accounted for by the mine discharges. "na": The Mine Q – dQ approach may not give insight to gage losses between stations, only the increases. However, it is quite possible for the entire mine discharge amount to be withdrawn from the river as part of the streamflow losses between gages.

Figure C-1. All Humboldt Basin Counties - Demand

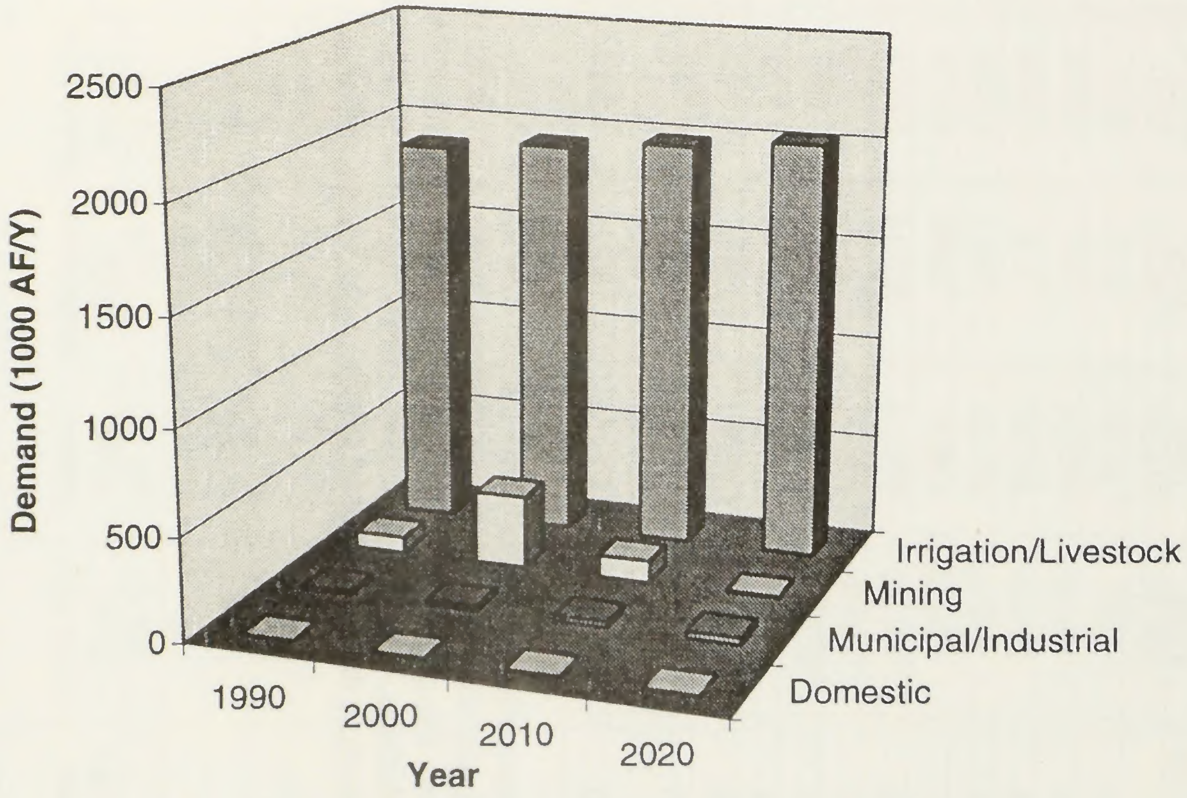
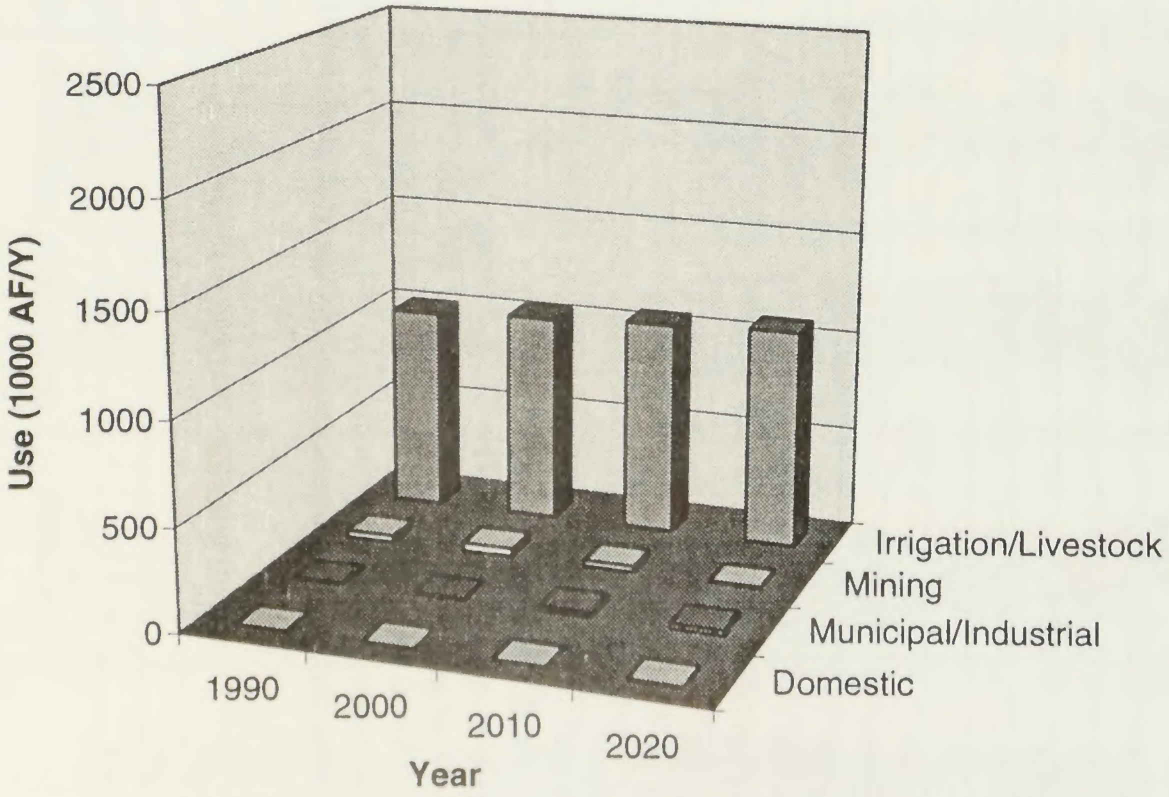


Figure C-2. All Humboldt Basin Counties - Consumptive Use



## Table C- 12
## Flow Changes Between Humboldt River Gages in Recent High-flow Years Compared with the Cumulative Mine Discharge
(all values are mean monthly flows in cfs)

| Month | Carlin Flow | Battle Mtn. Flow | Difference (dQ) | Cumulative Mine Q | Difference,[1] Mine Q – dQ | Battle Mtn Flow | Comus Flow | Difference (dQ) | Cumulative Mine Q | Difference,[1] Mine Q dQ |
|---|---|---|---|---|---|---|---|---|---|---|
| Jan-95 | 76.71 | 108.32 | 31.61 | 33.14 | 1.53 | 108.32 | 107.23 | -1.09 | 70.48 | na |
| Feb-95 | 233.21 | 248 | 14.79 | 36.69 | 21.90 | 248 | 279.36 | 31.36 | 74.03 | 42.67 |
| Mar-95 | 408.77 | 449.48 | 40.71 | 33.14 | -7.57 | 449.48 | 416.55 | -32.93 | 70.48 | na |
| Apr-95 | 482.13 | 551.27 | 69.14 | 18.99 | -50.15 | 551.27 | 490.87 | -60.4 | 79.67 | na |
| May-95 | 1155.81 | 1164.06 | 8.25 | 18.38 | 10.13 | 1164.06 | 687.32 | -476.74 | 79.05 | na |
| Jun-95 | 3132.33 | 2563.33 | -569 | 18.99 | na | 2563.33 | 2060.67 | -502.66 | 79.67 | na |
| Jul-95 | 1384.03 | 1417.87 | 33.84 | 13.03 | -20.81 | 1417.87 | 1450 | 32.13 | 73.71 | 41.58 |
| Aug-95 | 140.32 | 182.94 | 42.62 | 13.03 | -29.59 | 182.94 | 274 | 91.06 | 73.71 | -17.35 |
| Sep-95 | 48.87 | 52.1 | 3.23 | 13.47 | 10.24 | 52.1 | 71.57 | 19.47 | 74.14 | 54.67 |
| Oct-95 | 61.77 | 61.35 | -0.42 | 21.90 | 22.32 | 61.35 | 70.87 | 9.52 | 82.57 | 73.05 |
| Nov-95 | 78.07 | 98.2 | 20.13 | 22.63 | 2.50 | 98.2 | 113.77 | 15.57 | 83.30 | 67.73 |
| Dec-95 | 107.29 | 113.84 | 6.55 | 21.90 | 15.35 | 113.84 | 126.74 | 12.9 | 82.57 | 69.67 |
| Jan-96 | 141.23 | 181.03 | 39.8 | 15.63 | -24.17 | 181.03 | 199.32 | 18.29 | 70.21 | 51.92 |
| Feb-96 | 407.62 | 446.03 | 38.41 | 17.30 | -21.11 | 446.03 | 423 | -23.03 | 71.88 | na |
| Mar-96 | 1019.77 | 1457.06 | 437.29 | 15.63 | -421.66 | 1457.06 | 1114.13 | -342.93 | 70.21 | na |
| Apr-96 | 1126.93 | 1723.67 | 596.74 | 15.85 | -580.89 | 1723.67 | 1433.33 | -290.34 | 70.43 | na |
| May-96 | 1372.35 | 1604.84 | 232.49 | 15.34 | -217.15 | 1604.84 | 1142.16 | -462.68 | 69.92 | na |
| Jun-96 | 1334.4 | 1606.63 | 272.23 | 15.85 | -256.38 | 1606.63 | 1320.5 | -286.13 | 70.43 | na |
| Jul-96 | 237.48 | 415.1 | 177.62 | 14.80 | -162.82 | 415.1 | 369.1 | -46 | 69.38 | na |
| Aug-96 | 45.29 | 41.74 | -3.55 | 14.80 | na | 41.74 | 69.39 | 27.65 | 69.38 | 41.73 |
| Sep-96 | 22.17 | 14.5 | -7.67 | 15.29 | na | 14.5 | 38 | 23.5 | 69.87 | 46.37 |
| Oct-96 | 27.84 | 31.65 | 3.81 | 35.37 | 31.56 | 31.65 | 51.65 | 20 | 89.95 | 69.95 |
| Nov-96 | 60.4 | 109.17 | 48.77 | 36.55 | -12.22 | 109.17 | 128.03 | 18.86 | 95.32 | 76.46 |
| Dec-96 | 142.26 | 234.84 | 92.58 | 35.37 | -57.21 | 234.84 | 211.16 | -23.68 | 94.15 | na |
| Jan-97 | 394.32 | 1123.32 | 729 | 27.87 | -701.13 | 1123.32 | 750.42 | -372.9 | 89.51 | na |
| Feb-97 | 391.14 | 812.79 | 421.65 | 30.86 | -390.79 | 812.79 | 774.93 | -37.86 | 92.50 | na |
| Mar-97 | 1070.23 | 1693.03 | 622.8 | 27.87 | -594.93 | 1693.03 | 1304.45 | -388.58 | 82.91 | na |
| Apr-97 | 1020.37 | 1533.33 | 512.96 | 28.23 | -484.73 | 1533.33 | 1604.33 | 71 | 83.27 | 12.27 |
| May-97 | 1646.13 | 1910.97 | 264.84 | 27.32 | -237.52 | 1910.97 | 1482.26 | -428.71 | 82.36 | na |
| Jun-97 | 2055.53 | 2074 | 18.47 | 28.23 | 9.76 | 2074 | 2100 | 26 | 74.46 | 48.46 |
| Jul-97 | 307.77 | 509.87 | 202.1 | 14.61 | -187.49 | 509.87 | 595.68 | 85.81 | 60.84 | -24.97 |
| Aug-97 | 124.23 | 137.77 | 13.54 | 14.61 | 1.07 | 137.77 | 149.39 | 11.62 | 60.84 | 49.22 |
| Sep-97 | 45.67 | 63.6 | 17.93 | 23.20 | 5.27 | 63.6 | 81.97 | 18.37 | 76.04 | 57.67 |
| Oct-97 | 54.23 | 168.94 | 114.71 | 159.72 | 45.01 | 168.94 | 174.94 | 6 | 212.55 | 206.55 |
| Nov-97 | 86.5 | 255.83 | 169.33 | 160.82 | -8.51 | 255.83 | 257.63 | 1.8 | 222.46 | 220.66 |
| Dec-97 | 92.29 | 328.13 | 235.84 | 159.72 | -76.12 | 328.13 | 303.32 | -24.81 | 221.36 | na |
| Jan-98 | 225.52 | 426.29 | 200.77 | 141.73 | -59.04 | 426.29 | 476.71 | 50.42 | 191.73 | 141.31 |
| Feb-98 | 253.18 | 440.96 | 187.78 | 146.12 | -41.66 | 440.96 | 578.14 | 137.18 | 196.12 | 58.94 |

## Table C- 12 (Continued)
## Flow Changes Between Humboldt River Gages in Recent High-flow Years Compared with the Cumulative Mine Discharge
## (all values are mean monthly flows in cfs)

| Month | Carlin Flow | Battle Mtn. Flow | Difference (dQ) | Cumulative Mine Q | Difference,[1] Mine Q – dQ | Battle Mtn Flow | Comus Flow | Difference (dQ) | Cumulative Mine Q | Difference,[1] Mine Q dQ |
|---|---|---|---|---|---|---|---|---|---|---|
| Mar-98 | 457.61 | 703.94 | 246.33 | 141.73 | -104.60 | 703.94 | 714.71 | 10.77 | 191.73 | 180.96 |
| Apr-98 | 822.77 | 1322.33 | 499.56 | 65.37 | -434.19 | 1322.33 | 939.27 | -383.06 | 129.66 | na |
| May-98 | 1808.1 | 2262.26 | 454.16 | 64.85 | -389.31 | 2262.26 | 1967.77 | -294.49 | 129.13 | na |
| Jun-98 | 2655.33 | 2918.67 | 263.34 | 65.37 | -197.97 | 2918.67 | 2683.67 | -235 | 129.66 | na |
| Jul-98 | 1036.42 | 1249.9 | 213.48 | 32.28 | -181.20 | 1249.9 | 1621.74 | 371.84 | 96.56 | -275.28 |
| Aug-98 | 137.74 | 210.97 | 73.23 | 32.28 | -40.95 | 210.97 | 324.61 | 113.64 | 96.56 | -17.08 |
| Sep-98 | 58.87 | 95.37 | 36.5 | 32.95 | -3.55 | 95.37 | 152.63 | 57.26 | 97.23 | 39.97 |

Source: USGS 1999; Barrick 1999; and Newmont 1999a, b.

[1] A positive Mine Q - dQ indicates the possibility that some or all of the mine discharge is involved in the flow increase.
Negative Mine Q - dQ indicates that there is more gain in the streamflow between the gages than can be accounted for by the mine discharges.
na: The Mine Q - dQ approach may not give insight to gage losses between stations, only the increases. However, it is quite possible for the entire mine discharge amount to be withdrawn from the river as part of the streamflow losses between gages.

# TREATMENT OF STREAMFLOW DATA

The USGS streamgage data sets have periods of discontinuous records, particularly at Battle Mountain and the Argenta gage (which is no longer in operation). This is typical for most long-term gaging networks, as a result of changing data collection priorities through the years, the river stability at the gaging location, or the operation of instruments under remote and often harsh conditions. In recent years, additional data has been collected at the Old U.S. Highway 40 Bridge at Dunphy, just upstream of Barrick's discharge outfall. Less than 10 years of record currently exist for this site. Further information regarding the agency streamgaging and data compilation program can be obtained from the USGS, Water Resources Division, in Carson City and Elko, Nevada.

Tabulations of average daily flows for the Battle Mountain and Argenta gages were developed using the historical data available for these gages. Statistical distributions of these data indicate that the flows at both locations show a distinct central tendency. On the basis of this result, it was determined that the analysis should consider the effects to the average monthly flow hydrograph. The monthly flow hydrograph was developed by averaging the instantaneous daily flow values for each month, using the USGS streamgaging data. In the RTi analysis, data filling was conducted for periods when data were missing at Battle Mountain and Argenta as described below.

Under RTi's approach, if necessary data were missing for a particular gage or period, a continuous record was statistically synthesized. This was produced solely for analysis purposes using a statistical approach based on available upstream and downstream data characteristics (RTi 1998). Data-filling was conducted for the Battle Mountain gage (1981 through 1991) and Argenta gage (1982 through 1996), by loading all available daily values into a database. Statistical time series tools were applied to explore correlations with the other gages for the available periods of data. Both linear and logarithmic regression equations for streamflows were then developed for the Battle Mountain and Argenta gages in terms of flows at the other gages. Linear regression produced the most useful relationships. As summarized on a monthly basis in Table C-13 below, the most useful correlations were found with the Carlin gage.

**Table C-13**
**Data Filling Results**
**Monthly Correlation Coefficients (r squared values) with the Carlin Gage**

| Station | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Battle Mountain | 0.89 | 0.93 | 0.96 | 0.94 | 0.94 | 0.90 | 0.97 | 0.96 | 0.85 | 0.91 | 0.96 | 0.98 |
| Argenta | 0.94 | 0.99 | 0.98 | 0.99 | 0.96 | 0.97 | 0.99 | 0.92 | 0.64 | 0.81 | 0.96 | 0.97 |

**Streamflow Simulations**. The immediate influence of the projected mine discharges to the surface water environment of the Humboldt River was analyzed by developing a simple river network model of the Humboldt River in order to simulate the immediate influence of the projected average instantaneous mine discharges presented in Chapter 5.0. This analysis, although simplified, makes an attempt to explicitly account for irrigation diversions and lagged return flows.

The model chosen for this analysis is the Stream Simulation Model (StateMod) (Colorado Division of Water Resources 1996) as developed by the State of Colorado. StateMod is a monthly water allocation and accounting model that simulates irrigation diversions, reservoir storage, reservoir operations, and instream flow requirements based on the prior appropriation doctrine, the same legal standard used in Nevada. Water diversions are based upon priorities or (in a sense), rights.

StateMod represents the river basin using a network of nodes to reflect the stream system's physical and legal operational parameters. The nodes are located at major stream features, including stream gaging stations, diversion structures, minimum streamflow reaches, and locations for water imports (mine discharges) into the stream system.

StateMod first computes the baseflows for the river basin of interest. Baseflows are defined as those flows available in a stream system in the absence of human activity. StateMod generates baseflows using an inverse modeling approach in which the monthly streamflow data at the known gages are adjusted by adding back into the gage value depletions attributable to historic diversions. Once this baseflow file is created, the model allocates water on assigned priority sequence. For each priority, the amount of water available at a structure is calculated by observing the flow at the node and at all other downstream nodes to the lower end of the basin. The available flow is generally the minimum of physical availability, legal availability, demand, and capacity. After the diversion is made for the first priority, the flows at all of the nodes are adjusted downstream to reflect the diversion and any return flows. The general river network modeled for the Humboldt River analysis is shown in Figure C-3.

The process is then repeated for the next priority. The amount of water available for the next priority can include any return flow that accrues to the river from the more senior diversions that occur in the same monthly time step and return flows from previous time steps. The returns are assigned to accrue to one or multiple locations in the network, and vary in time depending on the return pattern. Return flows are specified as a percentage of the diversion assigned return flows, including both surface and ground water components.

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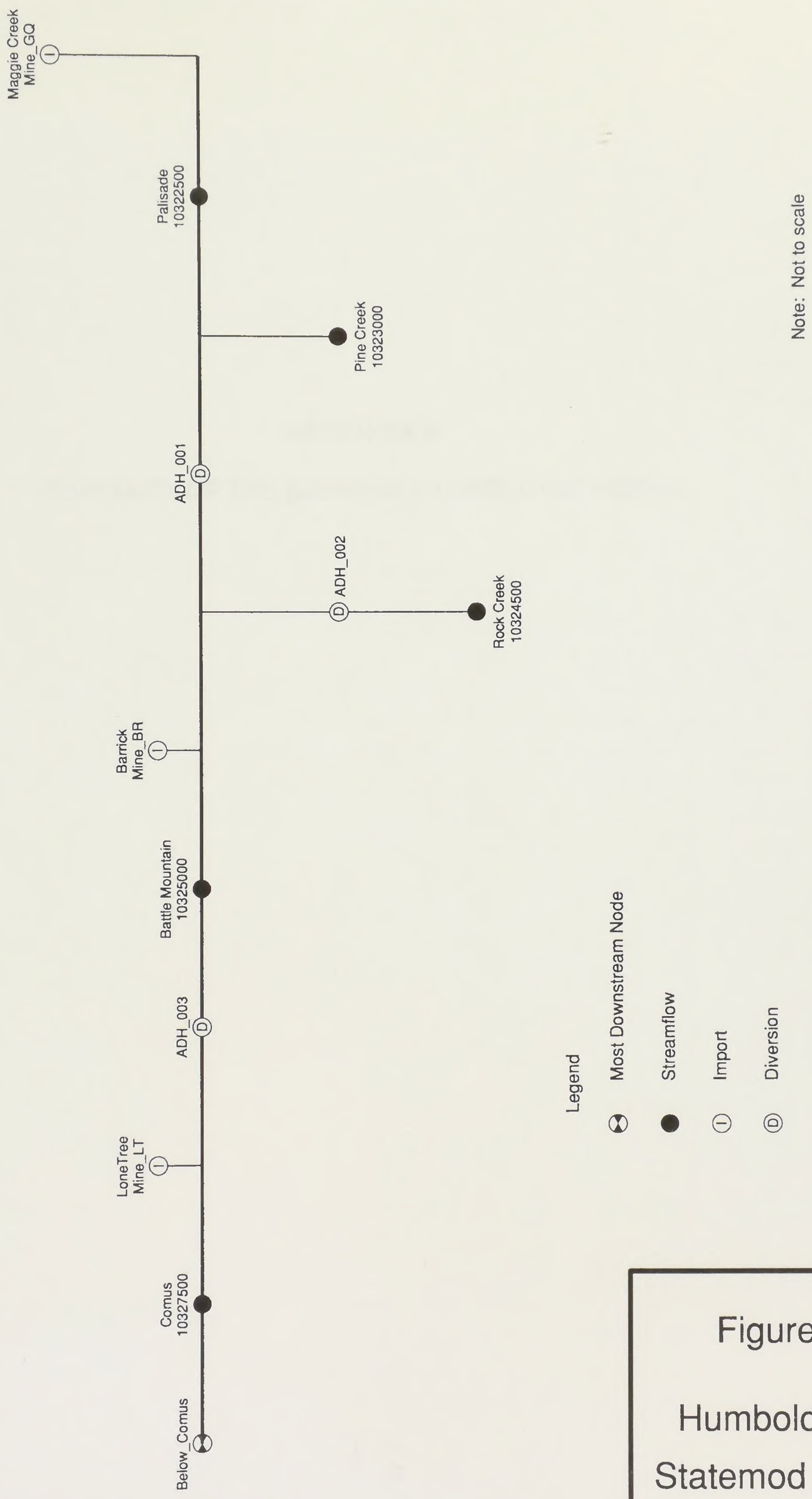

Figure C-3

Humboldt River Statemod Network

# APPENDIX D

# SUMMARY OF THE BARRICK HYDROLOGIC MODEL

# D1 .0 BARRICK MODEL

The dewatering requirements, general area of drawdown and mounding of ground water levels, and postclosure pit lake development were estimated using the U.S. Geological Survey (USGS) modular three-dimensional, finite-difference ground water flow model MODFLOW (McDonald and Harbaugh 1988). The calibrated model was used to simulate the hydrologic effects resulting from: (1) the Goldstrike Mine (independent of other dewatering activities in the northern Carlin Trend area) and, (2) the combined or cumulative dewatering and water management activities at the Goldstrike Mine, Gold Quarry Mine (from existing operation and proposed expansion) and proposed Leeville Mine. This section provides a summary of the model setup and presentation of the results of the modeling under the cumulative scenario. Details regarding the model design, model modifications, calibration, simulations, and sensitivity analyses are presented in McDonald Morrissey Associates, Inc. (1998).

## D1.1 Model Setup, Assumptions, and Calibration

### D1.1.1 Introduction

MODFLOW is designed to simulate flow in an anisotropic, heterogeneous porous medium. As described in Section 3.1.2, the hydrogeology of the region is controlled by flow thorough both porous sediments and fractured rock aquifers. Flow within porous media occurs within interconnected pores within the sediments and sedimentary rocks. Flow within the fractured rock is controlled primarily by a network of interconnected fractures and locally by flow through solution cavities in carbonate rocks. For the purpose of developing the regional numerical model, it was assumed that flow through the fractured medium can be treated as equivalent to flow within a porous medium. This assumption of an equivalent porous medium for the bedrock aquifers is consistent with the distribution of fractures observed in cores and reported during drilling (McDonald Morrissey Associates, Inc. 1998), and the general patterns of drawdown and mounding that have been observed to date in bedrock areas (Barrick 1999a). Flow through discrete fractures or solution cavities is not explicitly represented in the model. The model also assumes that the temperature of the ground water will remain constant throughout the model simulation periods.

Key components of the ground water flow model include (McDonald Morrissey Associates, Inc. 1998):

- Precipitation varies seasonally, with greater precipitation occurring during April through June (wetter months), compared to October through December (drier months).
- Recharge to ground water occurs as both a percentage of precipitation that infiltrates where it falls, and as infiltration of runoff along streams.
- Little hydraulic communication occurs between the modeled area and areas outside the model; however, there is some ground water flow to and from the model from the south.
- Modeled pumping rates for the 1990 through 1996 period vary according to actual mine pumping records.

- Most of the pumped ground water originates from water stored in the marine carbonate rocks and, to a lesser extent, the marine clastic rocks.
- Most of the infiltration that has occurred caused by mine water management activities has been confined to the volcanic rocks and alluvium in the area.
- Bedrock ground water flow is compartmentalized and controlled by near vertical faults.
- Higher permeability rocks exist between the Post and Siphon faults caused by increased fracture density and solution cavities.

### D1.1.2 Model Grid and Discretization

The numerical model domain and finite difference grid is illustrated in Figure D-1 (McDonald Morrisey Associates, Inc. 1998). The modeled area includes six ground water basins: Susie Creek, Maggie Creek, Marys Creek, Boulder Flat, Rock Creek, and Willow Creek described in Section 3.1.1. The model domain extends approximately 50 miles east-west and 60 to 70 miles north-south. In order to provide more detailed flow information in the mine area, the grid cell dimensions vary from 75 feet in the mine area to 10,000 feet at the model boundaries. Four model layers were used to vertically subdivide the modeled area. The vertical and horizontal discretization was designed to simulate variations in the hydraulic properties of the six general hydrostratigraphic units recognized in the modeled area. The top of the first layer is the water table; layer four generally represents the top 2,000 feet of low-permeability marine carbonate rocks.

### D1.1.3 Hydrostratigraphic Units

Six primary hydrostratigraphic units were further subdivided into model zones to represent variable hydraulic conductivity and storage properties within the units. The initial hydraulic parameters for the model were estimated from earlier model versions. The model parameters were then refined by model calibration. This process led to the selection of the 15 model zones shown in Table D-1. The most permeable rocks in the modeled area are fractured volcanics and carbonates, and alluvium. These rocks have hydraulic conductivities that are 1,000 to 10,000 times greater than most of the rocks in the study area (McDonald Morrissey Associates, Inc. 1998).

### D1.1.4 Hydrostructural Units

Long-term monitoring of drawdown and mounding in the vicinity of the Goldstrike property has resulted in the recognition of three major faults or fault zones that tend to impede the movement of ground water across the faults. These faults include the (1) Boulder Narrows Fault located in Boulder Valley; (2) Siphon Fault located between the TS Ranch Reservoir and the Betze-Post Pit; and (3) Post Fault located on the east side of the Betze-Post Pit. The locations of these major hydrostructural features are illustrated in Figure D-2 (McDonald Morrisey Associates, Inc. 1998) and a generalized cross section is shown in Figure D-3 (Barrick Goldstrike Mines Inc. 1999a).

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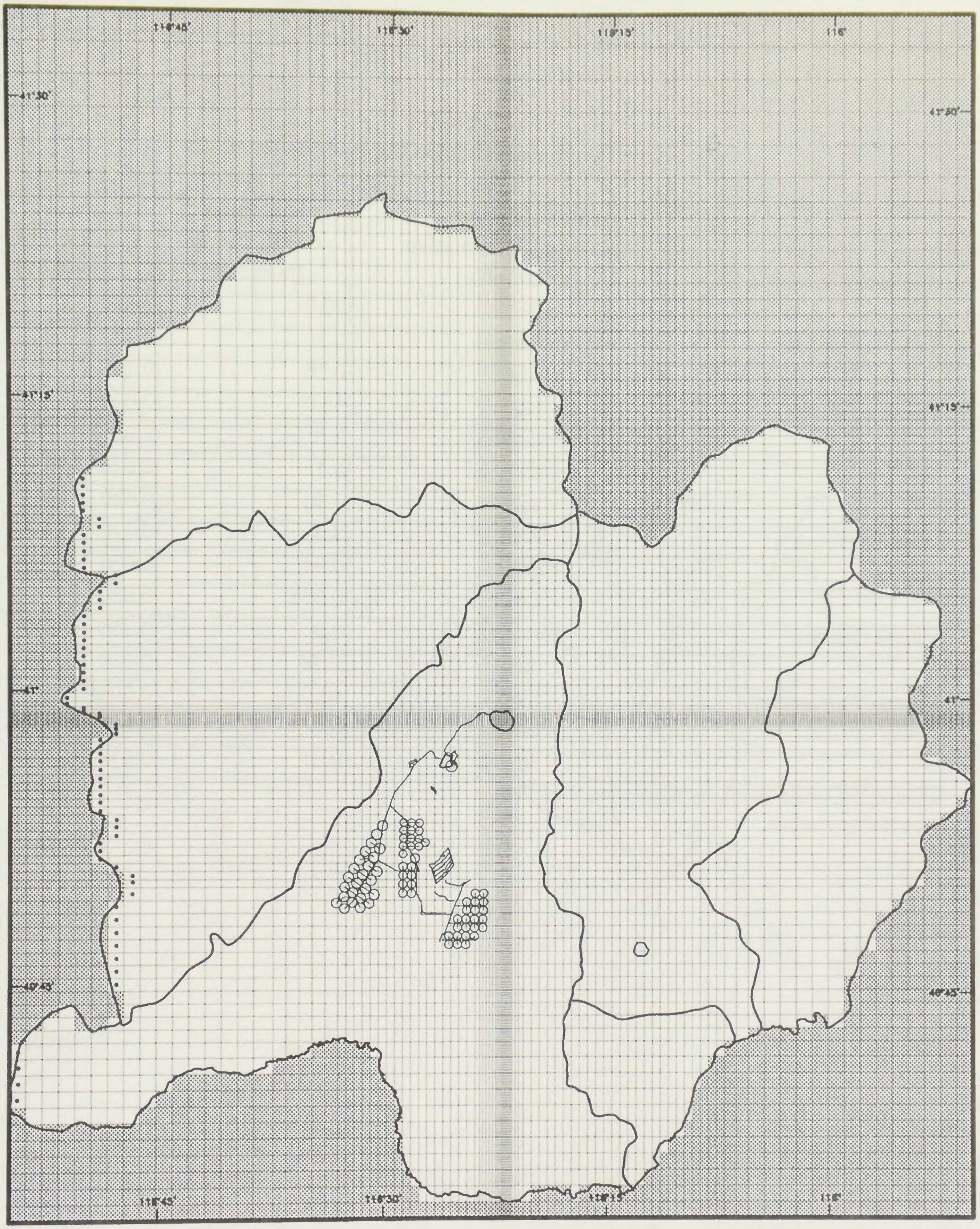

Figure D-1

Numerical Ground Water Flow Model Domain and Grid

## Table D-1
## Hydraulic Parameters Used in the Hydrologic Model

| Hydrostratigraphic Unit | Model Zones (subdivided by relative permeability) | Hydraulic Conductivity (feet/day) | Storage (unitless) |
|---|---|---|---|
| Alluvium | NA | 20.0 | 0.250 |
| Carlin Formation | moderate | 0.1 | 0.100 |
| | low | 0.05 | 0.050 |
| Volcanic Rocks | high | 45.0 | 0.030 |
| | medium high | 2.0 | 0.030 |
| | medium low | 0.1 | 0.030 |
| | low | 0.02 | 0.030 |
| Intrusive Rocks | high | 3.0 | 0.030 |
| | medium | 0.01 | 0.030 |
| | Low | 0.003 | 0.030 |
| Marine Clastics | medium | 0.2 | 0.030 - 0.050 |
| | low | 0.02 | 0.030 |
| Marine Carbonates | high | 40.0 | 0.008 - 0.016 |
| | medium | 0.1 | 0.010 - 0.030 |
| | low | 0.01 | 0.010 - 0.030 |

Source: McDonald Morrissey Associates, Inc. 1998.

NA = Not applicable.

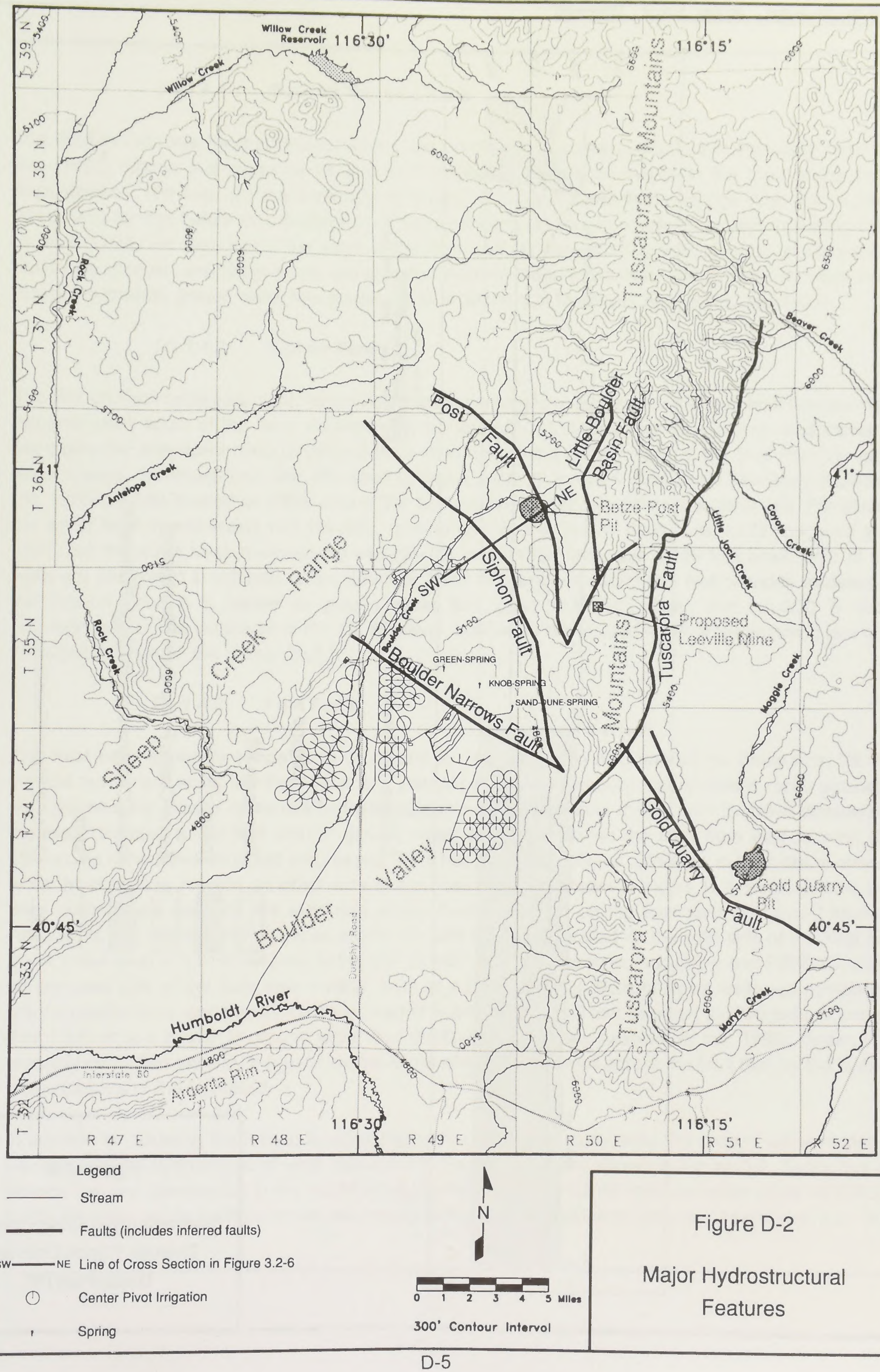

Figure D-2

Major Hydrostructural Features

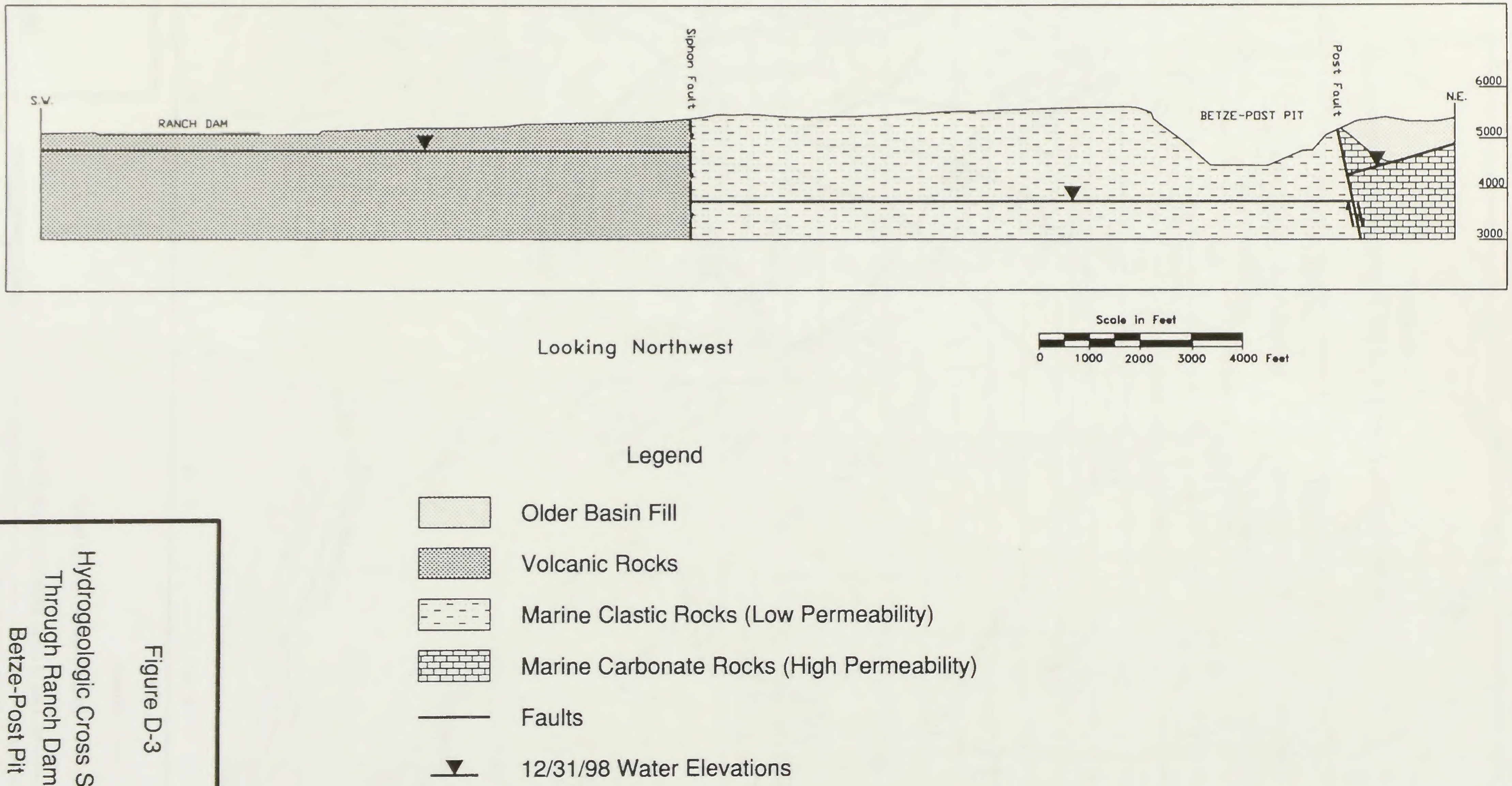

Figure D-3

Hydrogeologic Cross Section
Through Ranch Dam and
Betze-Post Pit

### D1.1.4.1 Boulder Narrows Fault

The Boulder Narrows Fault in Boulder Valley has no surface expression. McDonald Morrissey Associates, Inc. (1997) reports that evidence for this fault includes (1) offset of rhyolite in the area of the fault by approximately 700 feet, (2) the presence of Green, Knob, and Sand Dune springs (see the section on Seeps and Springs below for a description of these springs), (3) Newmont gravity surveys indicating that the basin is 3,000 feet deep just to the south of the fault, and (4) water-table gradients in the alluvium that are noticeably steeper, and water levels are elevated north of the inferred fault. The Boulder Narrows Fault is thought to impede ground water flow across the fault (McDonald Morrissey Associates, Inc. 1997).

### D1.1.4.2 Siphon Fault

The Siphon Fault separates highly permeable marine carbonate rocks north of the fault from less permeable volcanic rocks south of the fault. As illustrated in Figure D-3, the fault acts as a pronounced barrier that separates the drawdown cone developed from mine dewatering activity north of the fault from the ground water mound developed from the infiltration activities south of the fault (McDonald Morrissey Associates, Inc. 1996b). Wells located on either side of the fault record dramatically different water levels. For example, the water level in monitoring well NA-50D, located east of the Siphon Fault, was 4,375 feet amsl in late 1997, but the water level in monitoring well NA-7D, west of the fault, was 4,759 feet amsl. Both of these wells are completed in volcanic rocks, and their head difference of nearly 400 feet provides evidence that the Siphon Fault is a barrier to ground water flow (Barrick 1999a). (Note that NA-50D is located approximately 1 mile southeast of NA-7A. However, both wells are located within a few hundred feet of, but on opposite sides of, the Siphon fault.)

### D1.1.4.3 Post Fault

The Post Fault generally trends north-south and is exposed in the east wall of the Betze-Post Pit. Near vertical movement along the Post Fault has juxtaposed low permeability marine clastic rocks against the high permeability marine carbonate hydrostratigraphic unit. Exploratory drilling prior to active dewatering in the area revealed a 100-foot drop in ground water elevations across the fault from east to west (BLM 1991a). As mine dewatering has progressed, there has been a significant difference in the rates of observed water level decline in wells on either side of the Post Fault. As shown in Figure D-3, much greater water level declines are seen on the west side of the Post Fault than on the east side (McDonald Morrissey Associates, Inc. 1996b). For example, monitoring well PZ95-1D, located on the east side of the Post Fault, had a water level of 4,819 feet amsl at the end of 1997. At the same time, monitoring well PZ96-2D, located on the west side of the fault, had a water level of 4,214 feet amsl. Both of these wells are completed in marine clastic rocks, and the difference in head of approximately 600 feet between the two wells is evidence that the fault is a barrier to ground water flow (McDonald Morrissey Associates, Inc. 1998). Again, this is probably controlled more by the juxtaposition of the different rock types across the fault than by the hydraulic characteristics of the fault itself.

In addition to modeling the known hydrostratigraphic units in the study area, the ground water model also incorporated the hydrostructural units discussed in Section 3.1.2 and shown in Figure D-2. Faults that may impede flow are represented in the model using the horizontal flow barrier module designed for MODFLOW. Faults represented as barriers to flow are shown in Figure D-4 (McDonald Morrisey Associates, Inc. 1998),

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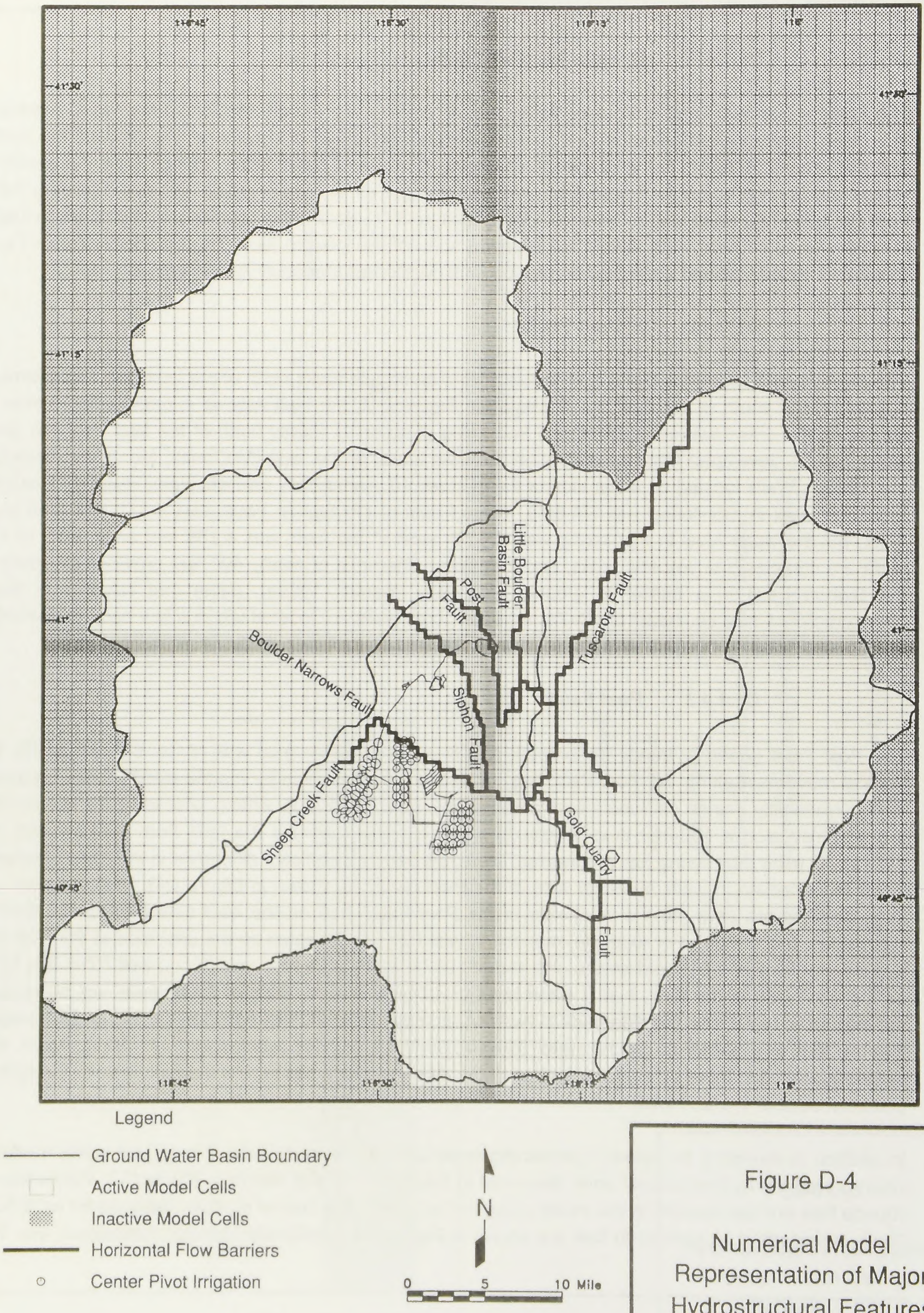

Figure D-4

Numerical Model Representation of Major Hydrostructural Features and include the Post, Siphon, Boulder Narrows, Gold Quarry, Tuscarora, Sheep Creek, and Little Boulder Basin faults. All of these faults were assumed to consist of a 100-foot wide low permeability zone. During the calibration process the assumed hydraulic parameters of the low permeability hydrostructural zones were modified to better represent the observed head distribution (McDonald Morrissey Associates, Inc. 1998).

### D1.1.5 Recharge, Evaporation, and Evapotranspiration

The numerical model incorporated ground water recharge due to direct infiltration and infiltration along stream channels and mountain fronts, as described in Section 3.1.2. Recharge along streams was simulated with the modified version of the RIV 2 Package (Miller 1988) River module of MODFLOW. Green, Sand Dune, and Knob springs, as well as the canal that captures their discharge also were modeled with the River Package. Seepage from the TS Ranch Reservoir and infiltration ponds was simulated as ground water injection with the Well Package. Ground water recharge from injection wells and irrigated areas also was simulated with the Well Package. Evapotranspiration from natural and irrigated areas was simulated in the model using the Evapotranspiration Package assuming an extinction depth of 20 feet from the land surface (McDonald Morrissey Associates, Inc. 1998).

### D1.1.6 Dewatering Wells, Injection Wells, Infilatration Ponds, and Irrigation

Mine dewatering wells were simulated with the Well Package for MODFLOW, and their pumping rates were selected to correspond to actual mine pumping records. Dewatering wells that penetrate more than one hydrostratigraphic unit were modeled as multiple wells in the same location that pump water from different layers. The pumping rates of these wells were proportioned according to the transmissivity of the rock units screened in the actual dewatering wells (McDonald Morrissey Associates, Inc. 1998). Infiltration from infiltration ponds, reservoir leakage, injection wells, and irrigation were also simulated using the Well module.

### D1.1.7 Model Calibration

The hydraulic conductivity estimates and zones, as well as the hydraulic characteristics of the low permeability faults, were modified during steady-state and transient model calibrations. In addition, model calibrations required small adjustments to the initial estimates for the ratio of vertical to horizontal hydraulic conductivity and for aquifer storage. Specifications for evapotranspiration and recharge from streams were represented by long-term seasonal averages and were not allowed to vary during model calibrations (McDonald Morrissey Associates, Inc. 1998).

The calibration procedure involved adjusting calibration parameters until the model was able to approximately match, within some relatively small degree of error, the ground water elevations and streamflows actually measured at various locations throughout the study area. Steady-state calibrations were used to adjust the model so that it would match premining heads at 144 wells and surface water flows at 6 sites prior to 1990. Transient calibrations were used to modify the model to match changes in heads at 76 wells and changes in streamflow at 6 locations due to mine dewatering and water management activities from 1987 through 1996. In this time period, water levels in the Betze-Post Pit area had fallen approximately

1,300 feet. As previously mentioned, historic records of mine pumping rates, injection rates, and irrigation rates were used to specify the transient stresses in the model (McDonald Morrissey Associates, Inc. 1998).

### D1.1.8 Sensitivity Analysis

A sensitivity analysis was performed to determine how sensitive the ground water flow model is to specified changes in certain model parameters. Results of the sensitivity analysis indicate that the model is very sensitive to changes in the hydraulic conductivity of the low-permeability marine clastic rocks, highly permeable volcanic rocks, alluvium, and high-permeability carbonate rocks. The model is also sensitive to changes in the storage properties of the high-permeability carbonate rocks and to changes in recharge (McDonald Morrissey Associates, Inc. 1998).

### D1.1.9 Simulated Premine Ground Water Elevations

The model simulated elevation of the regional ground water surface in the hydrologic study area prior to the initiation of mine dewatering and water management activities is shown in Figure D-5 (McDonald Morrissey Associates, Inc. 1998). According to this evaluation, the elevation of the potentiometric surface ranged from over 7,000 feet amsl in the Tuscarora Mountains to approximately 5,300 feet amsl in the vicinity of the mines, and less than 4,600 feet amsl in the lower part of Boulder Flat (McDonald Morrissey Associates, Inc. 1998.) Based on these elevations, the depth to ground water in the mountains prior to pumping was in the range of 150 to 400 feet below the land surface. In the vicinity of the mines, the depth was 200 to 400 feet. The premining depth to ground water in the rhyolite ranged from approximately 500 feet near the TS Ranch Reservoir to near land surface (0 to 50 feet) in the northern portion of Boulder Flat. In the alluvium in the southern half of Boulder Valley, depth to ground water was less than 10 feet near the Humboldt River (McDonald Morrissey Associates, Inc. 1996a).

## D1.2 Comparison of 1991, 1994, and 1998 Hydrologic Model Predictions of Drawdown from Barrick's Dewatering Operations

The numerical ground water model used by Barrick to simulate drawdown resulting from mine dewatering has been updated several times over the past decade in response to additional monitoring data, technical review, and modifications to Barrick's mining and dewatering plans. Figure D-6 presents the maximum areal extent of drawdown (> 10 feet) as projected by three different versions of the ground water model:

1) The original ground water model used for the Betze EIS (BLM 1991b). This model evaluated lowering the water table to 4160 feet amsl over a 10-year period and holding it there until the year 2000.

2) The revised ground water model used to predict drawdown for the Meikle Mine as authorized by the BLM in 1994 (BLM 1994c), and used for the Biological Assessment of Barrick's Dewatering Operations (BLM 1994b) and the associated Biological Opinion (USFWS 1994). This version of the model evaluated lowering the water table to 4160 feet amsl over a 5-year period and holding it there until 2000.

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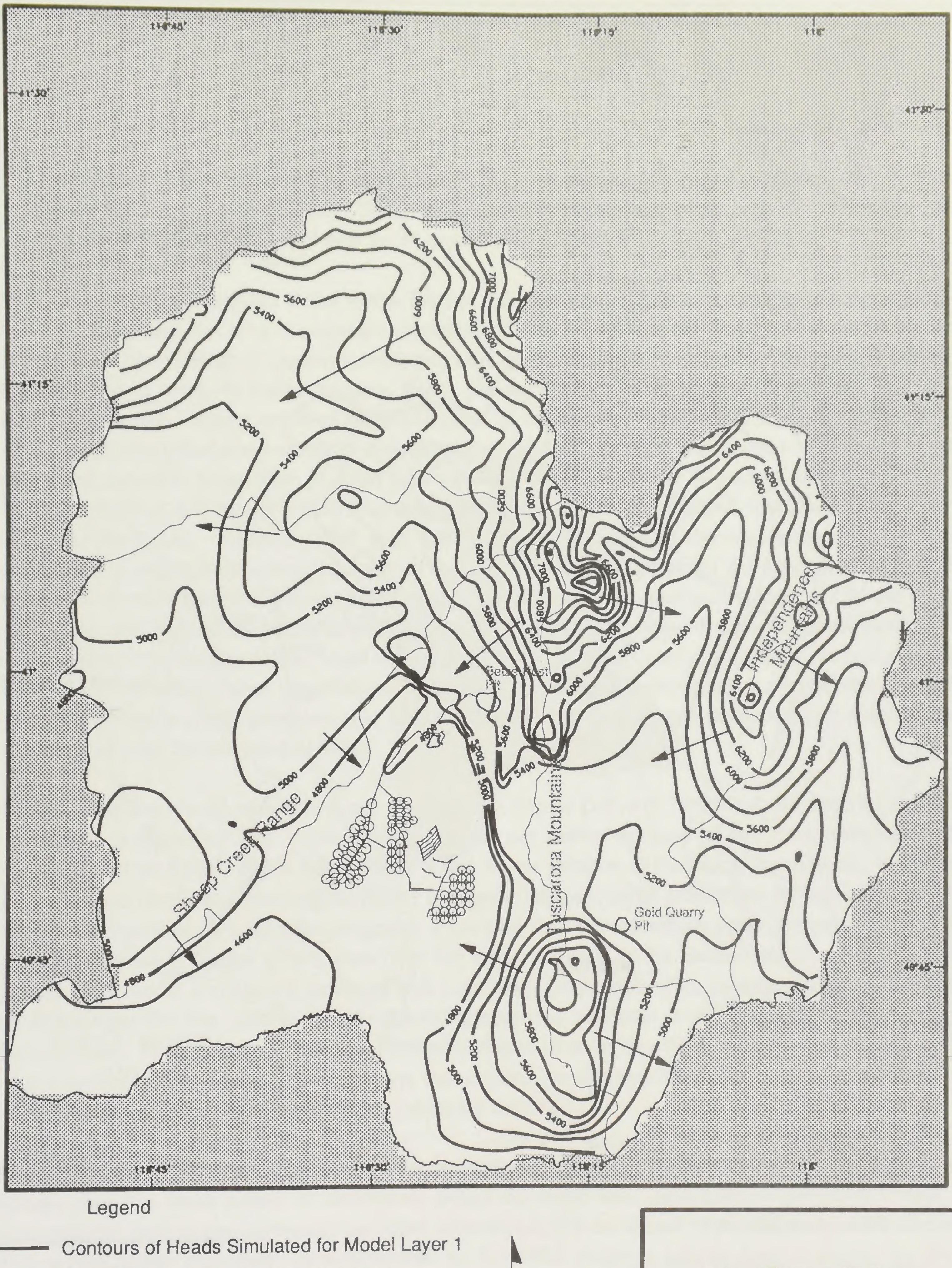

Legend

- Contours of Heads Simulated for Model Layer 1
- General Direction of Ground Water Flow
- Ground Water Basin Boundary
- ▨ Inactive Model Cells
- ○ Center Pivot Irrigation

N

0 5 10 Mile

200' Contour Interval

Figure D-5

Elevation of Premine Potentiometric Surface (Barrick Model)

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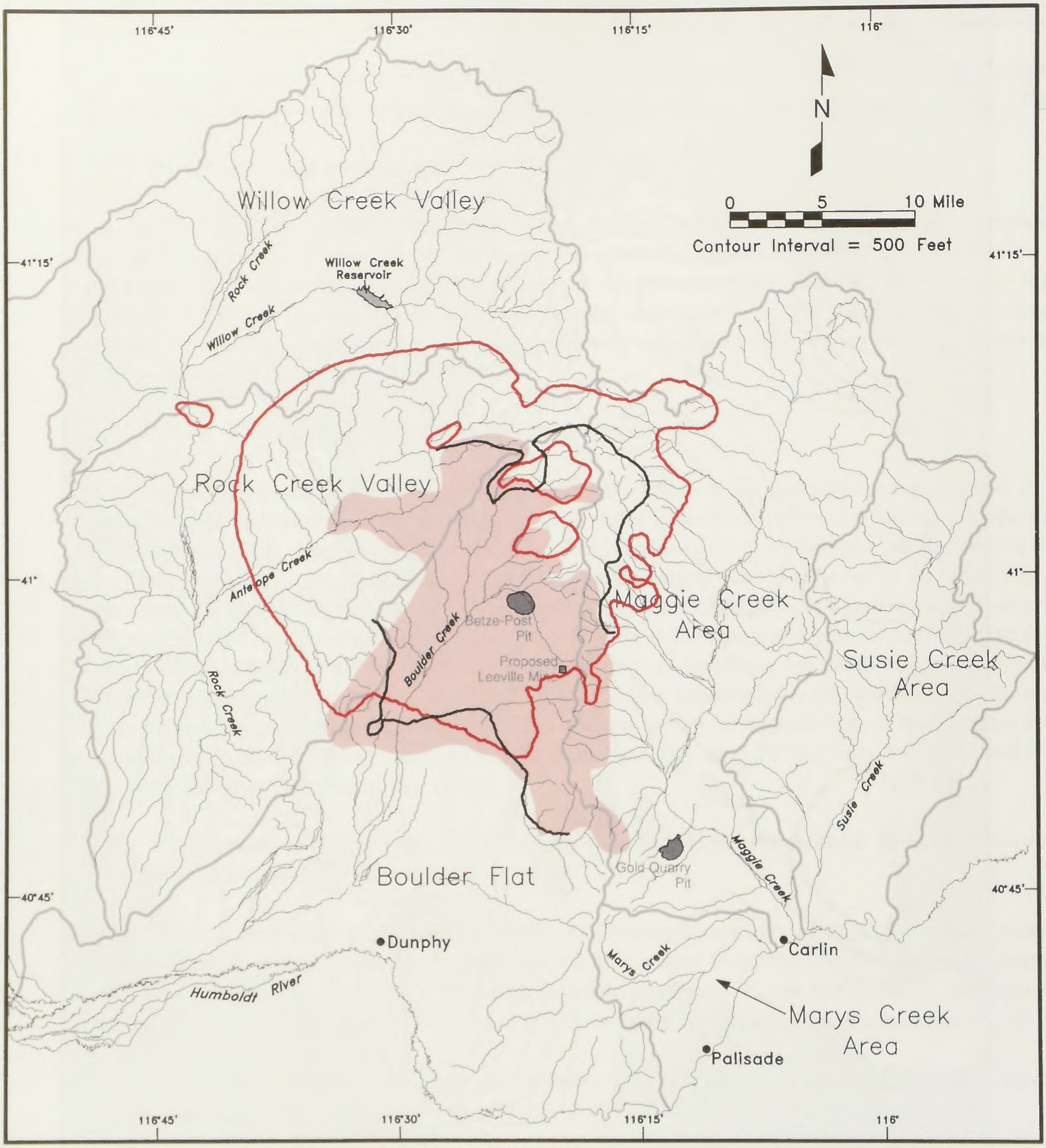

Legend

Ground Water Basin Boundary

Stream (Perennial, Intermittent, or Ephemeral)

1991 Projection - Betze Project EIS 1991 (BLM 1991a)

1994 Projection - Meikle Mine Development FONSI and Decision Record (BLM 1994c); Biological Assessment (BLM 1994b); and Biological Opinion (USFWS 1994)

1998 Projection - Betze Project Supplemental EIS (this document)

Figure D-6

Comparison of the 1991, 1994, and 1998 Hydrologic Model Projections of Drawdown from Barrick's Dewatering Operations

3) The revised ground water model used for this SEIS (McDonald Morrisey Associates, Inc. 1998; Barrick Goldstrike Mines Inc. 1998c). This version of the model evaluates lowering the water table to approximately 3600 feet amsl over an 11-year period and holding it there until 2010.

The initial modeling presented in the Betze Project EIS preceded any substantial dewatering activities. As shown in Figure D-6, the area of projected drawdown for this model was truncated by the model boundaries. For the 1994 dewatering simulation associated with approval of the Meikle Mine, the model domain was expanded out to major drainage features (Rock Creek, Willow Creek, Maggie Creek, and the Humboldt River) and allowed for simulation of the entire cone of depression. The model was also calibrated to the actual dewatering rates and measured drawdown data and was revised to account for the more aggressive dewatering schedule (drawdown to 4160 feet amsl in 5 years instead of 10 years). Monitoring since 1994 has indicated that this model version tended to overpredict drawdown, particularly toward the northwest, north, and northeast. Between 1996 and 1998, the ground water model was extensively revised and recalibrated to reflect fault-controlled bedrock compartmentalization detected during post-1994 monitoring. The model domain also was expanded to include six hydrographic basins now included in the hydrologic study area, and revised as necessary to address other technical review comments developed during the SEIS process. The version of the model used for the SEIS more accurately reflects the magnitude and areal extent of the drawdown cone observed to date and is considered to provide a more accurate projection of the extent of future areal drawdown due to the extensive monitoring data collection and recalibration that has occurred over the last several years.

The results of the model simulations are compared in Figure D-6 and Table D-2. As described previously, the original projections used in the Betze EIS did not define portions of the drawdown cone located northwest and southeast of the Betze-Post Pit due to the location of the model boundaries; therefore, it is not possible to compare drawdown cones for the three different model projections for these areas. All three models did, however, simulate the maximum areal extent of the drawdown cone (defined as the area that would experience ≥ 10 feet of drawdown) for the area northeast of the Betze-Post Pit. For this area, the original 1991 model simulations indicated that drawdown would extend up to approximately 10 miles from the Betze-Post Pit; the 1994 Meikle EA/BA/BO projections indicated that drawdown would extend up to approximately 13 to 14 miles; and the 1998 simulations used in this SEIS indicate that drawdown would extend approximately 7 miles. In summary, the updated model results indicate that the drawdown toward the northeast would be less than predicted by earlier models.

In comparing the 1994 and the 1998 model simulations, the 1998 model simulations used for the SEIS indicate that the areal extent of drawdown would be much less extensive in the Rock Creek Valley Hydrographic Area to the northwest, but more extensive to the southeast of the Betze-Post Pit. Overall, the areal extent of the drawdown cone simulated by the 1998 model is smaller than projected by the 1994 model (Figure D-6).

In comparison to earlier predictions, the 1998 model simulations used for the SEIS indicate that it will take substantially longer than previously projected for the drawdown cone to reach its maximum areal extent and recover to steady-state conditions. The 1998 model also projects that a larger volume of water would be withdrawn from the groundwater system during mining and reclamation. The increased volume of water projected by the 1998 model reflects the increased depth of dewatering (approximately 3600 feet amsl for the 1998 model versus 4160 feet amsl in the two earlier models), and the longer period during which that depth would be maintained (until 2010 versus 2000 for the earlier model scenarios).

**Table D-2**
**Comparison of 1991, 1994, and 1998 Model Projections**

| | Betze EIS (1991) | Meikle EA/BA/BO (1994) | Betze SEIS |
|---|---|---|---|
| Total Planned Pumped Volume at Closure – Acre-feet (Approximate) | 285,000 | 746,240 | 1,085,000 |
| End of Mining (and Dewatering) | 2000 | 2000 | 2010 |
| Target Dewatering Elevation (Approximate feet amsl) | 4160 | 4160 | 3600 |
| Years to Achieve Target | 10 | 5 | 11 |
| Years Postmining Until Maximum Areal Extent of Drawdown is Reached | 30 | 29 | 100 |
| Years Postmining Until Steady-state Recovery is Reached | 100 | 100 | >233 |

# APPENDIX E

# WATERFOWL DATA

## Table E-1
## Aerial Duck Breeding Pair Survey
## Average Number of Breeding Pairs Recorded Annually in Region 1
## (1959 – 1998)

| Area | 1959 – 1966 | 1967 – 1979 | 1978 – 1987 | 1980 – 1989 | 1990 – 1998 | 1959 – 1998 | High | Low |
|---|---|---|---|---|---|---|---|---|
| Humboldt River | 299 | 154 | 324 | 365 | 260 | 266 | 658 | 40 |
| Humboldt WMA | 312 | 472 | 388 | 398 | 161 | 357 | 1,049 | 0 |
| Stillwater WMA | 2,621 | 1,678 | 1,590 | 1,687 | 1,194 | 1,760 | 4,829 | 122 |
| Carson Lake | 985 | 908 | 1,235 | 1,362 | 1,006 | 1,059 | 2,251 | 63 |

Source: Saake 1998.

# Table E-2
# Annual Waterfowl Occurrence from August 15 to January 30
(1968 – 1997)
(x 1,000)

| Area | 1968 – 1977 | | 1978 – 1987 | | 1988 – 1997 | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| **Humboldt WMA**[1] | | | | | | | | |
| Ducks | 2,803.83 | 1,433.80 | 2,256.48 | 1,487.29 | 1,442,04 | 1,951,94 | 2,145.51 | 1,686.26 |
| Geese | 65.97 | 24.82 | 94.69 | 53.90 | 28.82 | 33.28 | 63.06 | 47.38 |
| Swans | 22.44 | 27.18 | 34.04 | 51.14 | 14.79 | 27.66 | 23.80 | 36.94 |
| **Stillwater WMA** | | | | | | | | |
| Ducks | 7,536.92 | 4,021.94 | 9,121.53 | 7,172.44 | 5,381.32 | 4,826.21 | 7,346.59 | 5,535.77 |
| Geese | 197.36 | 73.75 | 260.93 | 72.71 | 266.35 | 129.81 | 241.55 | 97.84 |
| Swans | 126.74 | 63.65 | 185.51 | 120.88 | 93.43 | 79.87 | 135.23 | 96.29 |
| **Carson Lake** | | | | | | | | |
| Ducks | 5,384.15 | 2,649.05 | 4,587.44 | 1,611.03 | 2,635.89 | 1,934.21 | 4,202.49 | 2,350.16 |
| Geese | 270.79 | 146.11 | 218.28 | 72.32 | 142.54 | 134.72 | 210.54 | 129.41 |
| Swans | 3.17 | 2.71 | 24.77 | 41.85 | 18.25 | 35.69 | 15.40 | 32.03 |

Source: Saake 1998.

[1] No data were obtained for the Humboldt WMA in 1968.

SD = standard deviation.

# Table E-3
# Humboldt Wildlife Management Area
# Annual Peak Population by Species
# August 15 – January 30
# (1969 – 1998)

| Species | Average (Aug 15 – Jan 30) | Average Yearlong | 1969 - 1998 | |
|---|---|---|---|---|
| | | | High | Low |
| Mallard | 3,074 | 6,148 | 12,880 | 1 |
| Gadwall | 1,994 | 3,988 | 10,530 | 0 |
| Northern pintail | 10,019 | 20,038 | 33,130 | 0 |
| Green-winged teal | 6,531 | 13,062 | 23,760 | 0 |
| Cinnamon teal | 700 | 1,400 | 3,260 | 0 |
| American wigeon | 4,455 | 8,910 | 14,850 | 0 |
| Northern shoveler | 2,581 | 5,162 | 13,500 | 0 |
| Redhead | 1,222 | 2,444 | 10,330 | 0 |
| Ring-necked duck | 98 | 196 | 2,050 | 0 |
| Canvasback | 1,162 | 2,324 | 15,880 | 0 |
| Lesser scaup | 7 | 14 | 30 | 0 |
| Common goldeneye | 3 | 6 | 20 | 0 |
| Bufflehead | 11 | 22 | 50 | 0 |
| Ruddy duck | 726 | 1,452 | 5,635 | 0 |
| Other duck species | 0 | 0 | 0 | 0 |
| **Total Ducks** | **32,583** | **65,166** | **76,625** | **1** |
| Common merganser | 706 | 1,412 | 6,800 | 0 |
| Dark goose | 729 | 1,458 | 2,640 | 0 |
| White goose | 20 | 40 | 300 | 0 |
| **Total Geese** | **749** | **1,498** | **2,940** | **0** |
| Tundra swan | 525 | 1,050 | 3,890 | 0 |
| American coot | 39,434 | 78,868 | 235,651 | 0 |
| **Total Waterfowl** | **73,997** | **147,994** | **315,468** | **1** |

Source: Saake 1998.

# APPENDIX F

# AQUATIC RESOURCES TABLES

## Table F-1

## Mean Fish Abundance[1] (number/mile) in the Maggie Creek Subbasin, 1992

| Stream | Location No. | Speckled Dace | Redside Shiner | Mountain Sucker | Brook Trout | Lahontan Cutthroat | Total |
|---|---|---|---|---|---|---|---|
| Buck Rake Jack Creek | BRJ-004 | 10 | 0 | 0 | 0 | 0 | **10** |
| West Cottonwood Creek | COW-001 | 1,070 | 0 | 0 | 0 | 0 | **1,070** |
| Coyote Creek | COY-002 | 0 | 0 | 0 | 10 | 0 | **10** |
| Indian Creek | IND-001 | 380 | 0 | 0 | 0 | 0 | **380** |
| Jack Creek | JAC-003 | 60 | 0 | 0 | 0 | 0 | **60** |
|  | JAC-004 | 10 | 0 | 0 | 0 | 0 | **10** |
| Little Jack Creek | LTL-007 | 20 | 0 | 0 | 0 | 150 | **170** |
| Maggie Creek | MAG-007 | 12,890 | 270 | 20 | 0 | 0[2] | **13,180** |
|  | MAG-102 | 3,180 | 680 | 0 | 0 | 0 | **3,860** |
| Susie Creek | SUS-010 | 13,410 | 190 | 280 | 0 | 0 | **13,880** |

Source: JBR 1992a.

[1] Number of fish/sampling segment (in feet) was extrapolated to number/mile.

[2] Five LCT were electroshocked by JBR (1992e) during a qualitative survey.

## Table F-2
## Mean Fish Abundance[1] (number/mile) in the Beaver Creek Drainage, 1994

| Stream | Location | LCT | | Tahoe Sucker | Speckled Dace | Lahontan Redside |
|---|---|---|---|---|---|---|
| | | Juvenile | Adult | All Stages | All Stages | All Stages |
| Beaver Creek | 1 | 0 | 10 | 10 | 578 | 0 |
| | 2 | 0 | 0 | 429 | 992 | 107 |
| | 3 | 0 | 0 | 116 | 2,988 | 0 |
| | 4 | 44 | 0 | 0 | 0 | 0 |
| | 5 | 0 | 0 | 0 | 112 | 0 |
| | 6 | 28 | 28 | 28 | 428 | 0 |
| | 7 | 15 | 15 | 0 | 47 | 0 |
| | 8 | 43 | 43 | 0 | 1,056 | 0 |
| | 9 | 128 | 0 | 0 | 0 | 0 |
| | 10 | 15 | 0 | 0 | 0 | 0 |
| | 11 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| Williams Canyon | 1 | 0 | 0 | 0 | 70 | 0 |
| | 2 | 81 | 0 | 0 | 0 | 0 |
| | 3 | 132 | 0 | 0 | 0 | 0 |
| | | | | | | |
| Toro Canyon | 1 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 170 | 34 | 0 | 0 | 0 |
| | 3 | 270 | 0 | 0 | 0 | 0 |
| | 4 | 114 | 0 | 0 | 28 | 0 |
| | 5 | 103 | 26 | 0 | 118 | 0 |
| | | | | | | |
| Toro Tributary A | 1 | 128 | 64 | 0 | 0 | 0 |
| Toro Tributary B | 1 | 313 | 0 | 0 | 0 | 0 |
| Toro Tributary C | 1 | 328 | 0 | 0 | 73 | 0 |
| | | | | | | |
| Barber Canyon | 1 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| Unnamed Trib. | 1 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| Little Beaver Ck. | 1 | 0 | 0 | 0 | 0 | 0 |
| | 2 | 634 | 70 | 0 | 0 | 0 |

Source: Valdez et al. 1994.

[1] Number of fish/sampling segment (in feet) was extrapolated to number/mile.

## Table F-3
## Mean Fish Abundance[1] (number/mile) in the Rock Creek Subbasin, 1996

| Stream | No. of Locations | Speckled Dace | Redside Shiner | Mountain Sucker | Tahoe Sucker | Lahontan Cutthroat | Total |
|---|---|---|---|---|---|---|---|
| Upper Rock Creek | 4 | 53 | 0 | 0 | 0 | 70 | **123** |
| Lewis Creek | 5 | 348 | 0 | 0 | 0 | 290 | **638** |
| Willow Creek | 9 | 2,823 | 396 | 211 | 92 | 0 | **3,522** |
| Nelson Creek | 6 | 1,571 | 53 | 106 | 0 | 79 | **1,809** |
| Toe Jam Creek | 5 | 334 | 0 | 88 | 0 | 106 | **528** |
| Frazer Creek | 4 | 3,590 | 0 | 0 | 0 | 853 | **4,443** |

Source: NDOW 1996b.

[1] Number of fish/sampling segment (in feet) was extrapolated to number/mile.

## Table F-4
## Location Descriptions of the Humboldt River Sampling Stations

| Station I.D. | Location Description |
|---|---|
| BG-HUM-01 | This station is located approximately 1/2 mile upstream of the mine at Barth. |
| BG-HUM-02 | This station is located approximately 1 mile below Cluro or approximately 5.5 miles downstream of BG-HUM-01. |
| BG-HUM-03 | This station is located approximately 5 river miles above Beowawe. |
| BG-HUM-04 | This station is located approximately 2 miles upstream from Dunphy. |
| BG-HUM-05 | This station is just downstream of Dunphy. It was the most upstream station in the initial August/September 1995 sampling. |
| BG-HUM-06 | This station is immediately downstream from Shoshone. It is in Eureka County near the Lander County line and above the confluence of Blue Horse Slough. |
| BG-HUM-07 | This station is located 2 miles below where Blue House Slough enters the river. It is in Lander County just west of the Eureka County line. |
| BG-HUM-08 | This station is situated near the gaging station north of Mosel. |
| BG-HUM-08a | This station is located at the levees in Lander County. |
| BG-HUM-09 | This station is downstream from Argenta at Argenta Siding. |
| BG-HUM-10 | This station is located approximately 2 miles above the confluence of Rock Creek. |
| BG-HUM-11 | This station is only a short distance downstream from the confluence of Rock Creek. |
| BG-HUM-12 | This station is located 2 miles below the Rock Creek confluence. It is situate immediately adjacent to the structures and buildings at Tomera Ranch. |

Source: JBR 1997.

## Table F-5
## Fish Species Collected in the Humboldt River

| Common Name | Scientific Name | Status | |
|---|---|---|---|
| | | Game Species | Nongame Species |
| **Suckers** | **Family Catostomidae** | | |
| Lahontan mountain sucker[1] | *Catostomus platyrhynchus* | | X |
| Tahoe sucker[1] | *Catostomus tahoensis* | | X |
| **Minnows and Carp** | **Family Cyprinidae** | | |
| Goldfish[2] | *Carassius auratus* | | X |
| Carp[2] | *Cyprinus carpio* | | X |
| Lahontan tui chub[1] | *Gila bicolor* | | X |
| Sacramento blackfish[2] | *Orthodon microlepidotus* | | X |
| Redside shiner[1] | *Rhichardsonius balteatus* | | X |
| Lahontan redside[1] | *Richardsonius egregius* | | X |
| Lahontan speckled dace[1] | *Rhinichthys osculus robustus* | | X |
| **Catfishes** | **Family Ictaluridae** | | |
| White catfish[2] | *Ictalurus catus* | X | |
| Black bullhead[2] | *Ictalurus melas* | X | |
| Brown bullhead[2] | *Ictalurus nebulosus* | X | |
| Channel catfish[2] | *Ictalurus punctatus* | X | |
| **Livebearers** | **Family Poeciliidae** | | |
| Mosquitofish[2] | *Gambusia affinis* | | X |
| **Perches** | **Family Percidae** | | |
| Yellow perch[2] | *Perca flavescens* | X | |
| Walleye[2] | *Stizostedion vitreum vitreum* | X | |
| **Temperate Basses** | **Family Percichthyidae** | | |
| White bass[2] | *Morone americana* | X | |
| **Sunfishes** | **Family Centrarchidae** | | |
| Green sunfish[2] | *Lepomis cyanellus* | X | |
| Bluegill[2] | *Lepomis macrochirus* | X | |
| Smallmouth bass[2] | *Micropterus dolomieui* | X | |
| Largemouth bass[2] | *Micropterus salmoides* | X | |
| White crappie[2] | *Pomoxis annularis* | X | |
| Black crappie[2] | *Pomoxis nigromaculatus* | X | |

Sources: Sevon 1994; JBR 1992a; French 1994, as cited in BLM 1996c; Emerson 1975; La Rivers 1962.

[1] Native species.

[2] Introduced species.

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